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# *EPOCH-MAKING BOOKS IN BRITISH SURGERY.*

BY SIR D'ARCY POWER, K.B.E., LONDON.

## XI. "MY BOOK" BY JOHN ABERNETHY.

JOHN ABERNETHY was the first of the great English surgeons of the last century to treat his patients by expectant means rather than by operation. He thus founded a school of British surgery based upon physiology rather than anatomy. The idea was fundamentally sound, but Abernethy was a pioneer, and as we now read his works it is easy to see how extraordinarily inadequate was the foundation upon which he built. He had no knowledge of physiology in the modern sense; his pathology was crude; he was ignorant of the part played by micro-organisms in disease; and when syphilis was rife he did not recognize either its later lesions, which we now call tertiary, or its hereditariness. Yet by sheer genius his conclusions are often correct, and later surgeons accepted the basis though they modified the teaching.

Abernethy put forward his theories in a book which he always spoke of as "My Book". It was rarely out of his thoughts. He spoke of it to his pupils, he dragged it into every lecture, he presented it to his patients. His classes were large and his patients many, so that "My Book" became one of the best-known works in the early part of the nineteenth century, and it was known officially as a treatise "On the constitutional origin and treatment of Local Diseases". It first appeared in 1806 under the title of "Surgical Observations, Part the second, containing an account of the disorders of the health in general and of the Digestive Organs in particular which accompany local diseases and obstruct their cure". The 2nd edition appeared in 1811, the 3rd in 1814, the 4th in 1817, the 5th in 1820, the 6th in 1822, the 7th in 1824, the 8th in 1826, the 9th in 1827, the 10th in 1827, the 11th in 1829, and Abernethy died in 1831.

The main thesis advanced by Abernethy was that errors of digestion were the *fons et origo* of many surgical disorders and that diet, gentle purging, and an open-air life would cure many of the conditions generally met with in surgical practice. This was probably true, for during the life of Abernethy the well-to-do habitually over-ate themselves, took but little exercise, drank a

great deal, and were usually constipated; whilst the poor were disgracefully housed, were indigent beyond conception, and were for the most part drunken. Neither rich nor poor were aware of the value of fresh air. He says:—

"Nothing in Pathology is more generally admitted than the reciprocal operation of disorders of the head and of the digestive organs on each other; yet the exceptions to this general rule deserve to be remarked in a comprehensive examination of the subject. Some persons have great disorder of the digestive organs without any apparent affection of the nervous system; and even diseases of a fatal nature may take place in the former organs without affecting the latter. Indeed if we examine any of the most evidently sympathetic affections we shall find the same exceptions. The stomach generally sympathizes with disorder of the uterus but it does not invariably do so.

"Many of the symptoms recorded in the description of the state of health of those persons who are affected by disorder in the digestive organs denote a disturbance of the nervous and muscular powers. When we observe this compound disorder we can seldom determine which were the primarily affected organs. The history will generally show that the derangement of the digestive organs is secondary. When it arises from local irritation, it can be produced only through the medium of the sensorium. When it is idiopathic it frequently originates in causes which affect the nervous system primarily, such as anxiety, too great exertion of mind or body and impure air. Sedentary habits and irregularities of diet are causes which may be supposed to act locally on the digestive organs themselves. Nervous irritability and weakness are not perhaps susceptible of a direct cure by medicine; but the disorders of the digestive organs are more corrigible by medical remedies. In practice these require our chief attention, and if their disorders be corrected all nervous irritation frequently ceases and health is restored. In many instances the nervous irritation which has induced the disease is trivial and would soon cease were it not kept up by the reaction of its effects.

"Whether this disorder of the digestive organs be primary or secondary it generally produces irritation in the brain; and thus may cause in many instances actual disease of that organ. The connection of local disease with general disorder has often been remarked; it has formerly been attributed to impurity of the fluids; a theory which is not irrational. Imperfect digestion must influence the qualities of the blood and all parts of the body may be affected from this source. But in accounting for the reciprocal influence of disorders of the head and the digestive organs on each other, the modern explanation of these phenomena by means of sympathies is perhaps preferable. Afflicting intelligence will destroy the appetite and produce a white tongue in a healthy person; a blow on the stomach disorders the head. These phenomena take place independently of the blood and can only be explained by admitting that disturbance of one organ immediately affects the other."

There is no doubt that Abernethy rode his hobby too hard, but he drew attention to the influence which the general health exercises over local conditions, and thus in some vague way seems to have foreshadowed the doctrine of immunity. He says about treatment:—

"I do not feel altogether competent to give full directions relative to this subject because I have never attended to medical cases with that degree

of observation which would lead me properly to appreciate the efficacy of different medicines when administered either in their simple or compounded forms." He gives, however, some simple rules as to diet, saying about food: "First, with respect to quantity. There can be no advantage in putting more food into the stomach than it is competent to digest, for the surplus can never afford nourishment to the body; on the contrary, it will be productive of various ills. Being in a warm and moist place the undigested food will undergo those chemical changes natural to dead vegetable and animal matter, the vegetable food will ferment and become acid, the animal will grow rancid and putrid. . . . Nature seems to have formed animals to live and enjoy health upon a scanty and precarious supply of food; but man, in civilized society, having food always at command and finding gratification from its taste and a temporary hilarity and energy result from the excitement of his stomach, which he can at pleasure produce, eats and drinks an enormous deal more than is necessary for his wants or welfare. He fills his stomach and bowels with food which actually putrefies in those organs. He fills, also, his bloodvessels till he oppresses them and induces diseases in them as well as in his heart. . . . In proportion as the powers of the stomach are weak so ought we to diminish the quantity of our food and take care that it should be as nutritive and easy of digestion as possible.

"Secondly, as to quality; It is not my intention to discuss the question as to the nature of the food proper to mankind but I may observe that its qualities should be adapted to the feelings of the stomach. In proof of this numerous instances might be mentioned of apparently unfit substances agreeing with the stomach, being digested and even quieting an irritable state of the stomach merely because they were suitable to its feeling. Instances might also be mentioned of changes in diet producing a tranquil and healthy state of stomach in cases where medicines had been tried in vain.

"Thirdly, as to the times of taking food. It is evidently the intention of nature that we should put into the stomach a certain portion of food, the excitement of which inducing a secretion of gastric fluid by its action becomes digested. This office of the stomach being effected it should be left in a state of repose till its powers are restored and accumulated, and this return of energy would, in a state of health, be denoted by a return of appetite. It is therefore reasonable to allot the same portion of time for the same purpose when the organ is disordered whilst we have diminished the quantity of our food in order to proportion it to the diminished powers of the organ; yet instead of pursuing this rational plan of diet many persons are taking food every third or fourth hour pleading in excuse for such conduct that they cannot do without it. The truth is, that when the stomach is disordered the exertion of digesting a single meal after its excitement and efforts have ceased is productive of sensations of languor, sinking and inquietude which ought to be calmed or counteracted by medicines and not by food, for a second meal cannot be digested in this state of the stomach. We also often tease and disorder our stomachs by fasting for too long a period; and when we have thus brought on what I may call a discontented state of the organ, unfitting it for its office we sit to a meal and fill it to its utmost, regardless of its powers or its feelings. The rules, then, for diet may be thus summarily expressed; We

should proportion the quantity of food to the powers of the stomach, adapt its quality to the feelings of the organ, take it at regular intervals of six or seven hours thrice during the day."

Abernethy's advice in regard to alcohol could not have proved very palatable to a generation somewhat addicted to its immoderate use. He says: "All stimulants must be regarded as medicines; vinous liquors are of this class and being very suitable to the feelings of the stomach are in many cases very useful. The rule for taking vinous liquors in persons to whom habit has rendered them necessary may be thus briefly stated. They should not take them during their meals lest the temporary excitement they produce should induce them to take more food than the powers of the stomach are capable of digesting but afterwards they may be allowed so much of them as may be required to induce agreeable feelings; or to express the fact more clearly, as is necessary to prevent those uncomfortable sensations which the want of them may occasion; and, it may be added, the less they take the better."

# ENTEROCYSTOMA.

By RUTH ELIZABETH MILLAR, Dunfermline;

and GEORGE ROBERTSON,

hon. surgeon to the dunfermline and west of fife hospital.

Enterocystomata are sufficiently rare to warrant a description of the rarest type of these peculiar and etiologically uncertain tumours. We recently operated on such a case in the Dunfermline and West of Fife Hospital, the patient being sent by one of our colleagues.

History.—J. F., a female, age 8 years, the youngest of a family of three, was a healthy child at birth and maintained good health until she reached the age of 4 years, when she began to complain of attacks of sickness accompanied by severe vomiting. Her mother states that each attack lasted twenty-four hours, had a sudden onset and an equally sudden termination, that the child was prostrated during the attacks, and that the vomit was only exceptionally bile-stained. At first the interval between attacks was two to three months, but later was reduced to one month, so that a periodicity suspiciously like that of the menses was established. Her mother actually imagined that even at this early age the little girl was suffering from a precocious development of the sexual glands. Thus she reached the age of 7 years, which was followed by such complete freedom from symptoms for a period of six months that it was thought her troubles had at last come to an end. Four months ago, however, the attacks returned with increased severity and frequency; severe vomiting, frequently bile-stained, and preceded and accompanied by pain in the right iliac fossa and epigastrium, continued for twenty-four hours with each attack. The intervals of freedom had shortened to two weeks. Within the last month a weekly attack has occurred. Right iliac pain had become so prominent a feature that she was sent to hospital for operation, with the diagnosis of appendicitis. We, having no opportunity to observe an attack and considering the diagnosis probably correct, operated.

Operation.—Operation, as for appendicectomy, was performed on May 4, 1929. Immediately the abdominal cavity was opened an abnormality was detected. An elongated, tense, cystic tumour was found superimposed upon the cæcum, the long axes of tumour and intestine being parallel (*Fig.* 190). The sausage-shaped mass possessed a typically intestinal appearance, exhibited peristalsis, and a constriction existed near its middle. Both ends were blind; that which pointed to the hepatic flexure was the larger and more bulbous, the other, little more than half the size, pointed downwards and slightly inwards and overlaid the vermiform appendix, which was normal. On its deep aspect, two-thirds of the tumour, measured from the smaller end, was connected by a mesentery to the true mesentery of the ileocæcal angle.

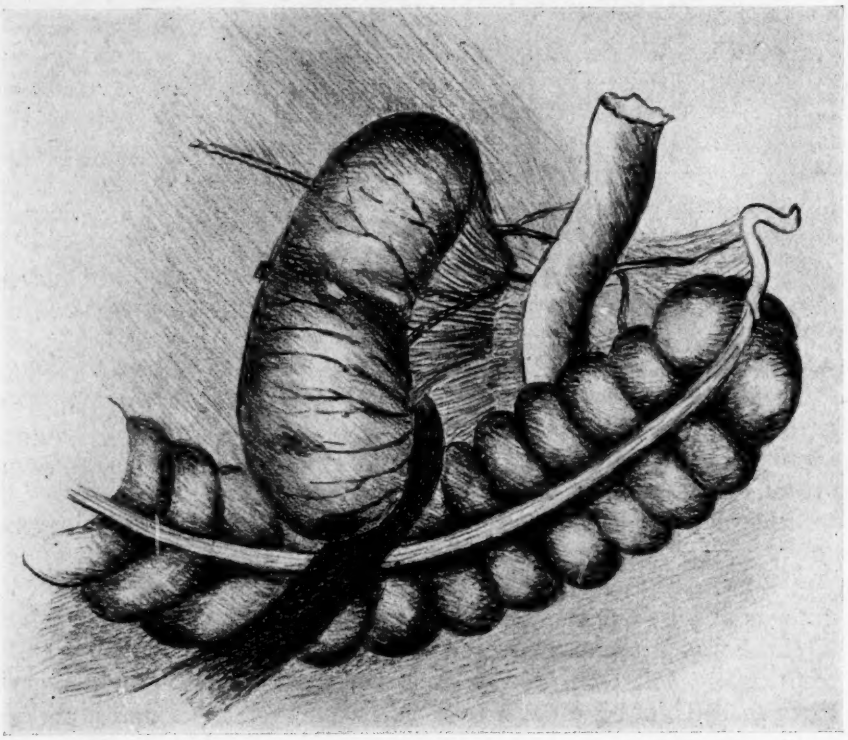

FIG. 191.—The cystoma rotated previous to removal: its attachments, mesentery and band, are well seen.

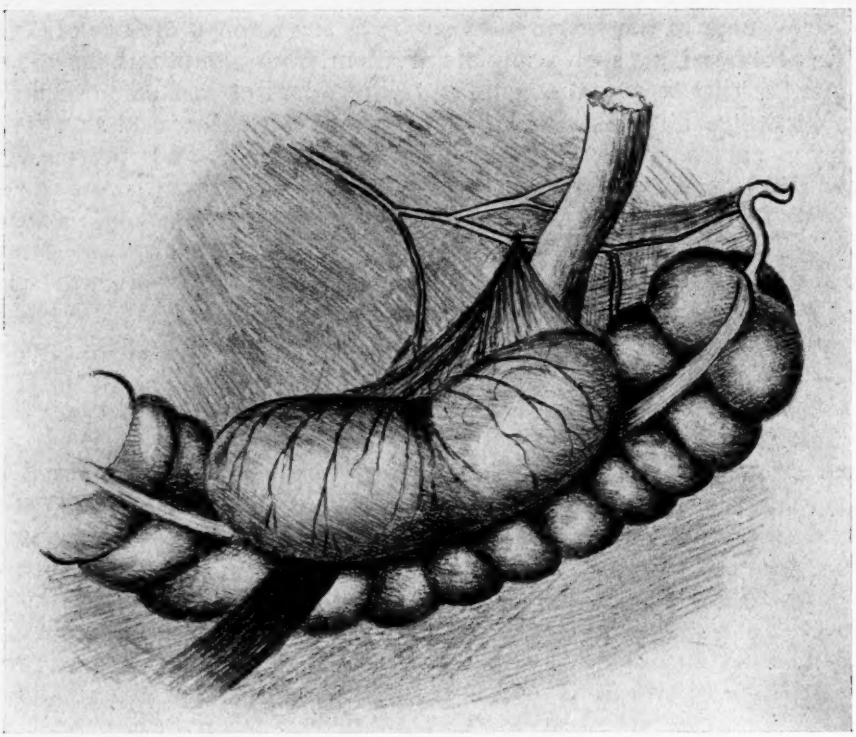

FIG. 190.—The appearances presented on opening the abdomen.

The inferior aspect of the larger bulbous end was less loosely attached by an apparently adventitious band to a pericolic membrane enclosing the ascending colon and blending on the lateral aspect of the gut with the parietal peritoneum. The loose pedicle allowed a fairly easy delivery of the cyst through the operation incision. The chief blood-supply of the tumour was directed to its mesenteric half from the ileocolic vessels, while in the adventitious band only capillaries existed, so that mass ligation was necessary only for the true mesentery of the cyst. A few tiny bleeding points were ligated over the colon when the tumour had been separated and removed. The cyst removed, no other abdominal abnormality could be seen. The appendix was resected and the wound closed.

After the patient had been removed from the operation room we inspected the cyst. As it lay on a cold specimen tray it showed active peristalsis, that wave being more pronounced which began at the small end and spread to the other, though the reverse wave was not inconsiderable. Light slapping

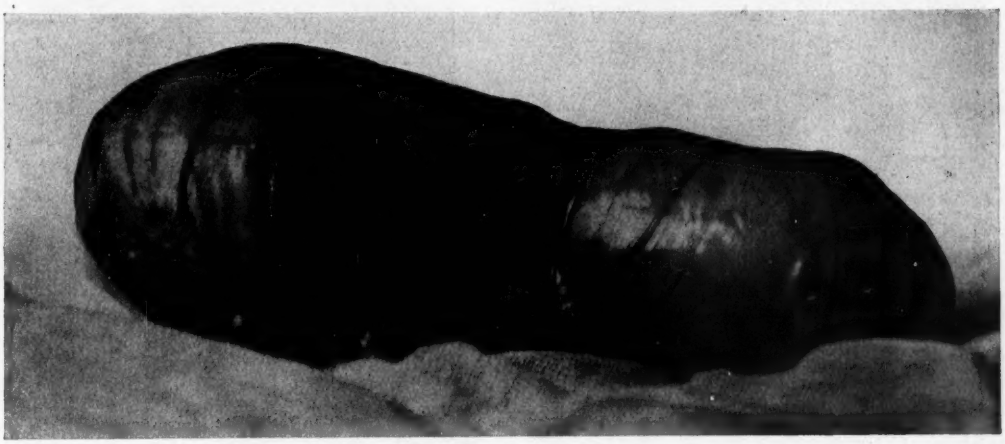

FIG. 192.—Cystoma after removal. (*Natural size.*)

of the cyst with a wet swab was at once followed by increased peristaltic movement, while the application of warm moist gauze pads excited the most vigorous peristalsis of all. These contractions ceased only after a lapse of over two hours, when repeated attempts, mechanical and thermal, failed to induce a response.

*Figs.* 190 and 191 were drawn immediately after operation. The general appearance suggests a piece of intestine, and, as will be seen from *Fig.* 192, two tiny appendices epiploicæ are situated in the sulcus on the lateral aspect of the tumour as it lay in the abdomen. Its length is 11 cm., the maximum girth at the bulbous end 10 cm., the mesenteric line of attachment is 10 cm., and the maximum length of pedicle 4 cm. Careful examination of the cyst by ourselves revealed no evidence of scar at either end of the cyst. We could therefore only hazard an opinion as to its possible origin. Two fluid ounces of an almost perfectly transparent viscous mucoid fluid constituted the content of the cyst, which was unilocular.

PATHOLOGICAL REPORT.—The Royal College of Physicians' Laboratory, Edinburgh, reported on the tumour as follows:—

*Fluid Content.*—Reaction, neutral; urea, 0·05 per cent; total protein, 0·15 per cent; stained and unstained films show catarrhal cells and polymorphs, no food débris seen.

FIG. 193.—Shows atrophic mucous membrane (reticular epithelial cells), with fragmentary gland elements (goblet cells). Well-marked muscularis mucosæ. (× 75.)

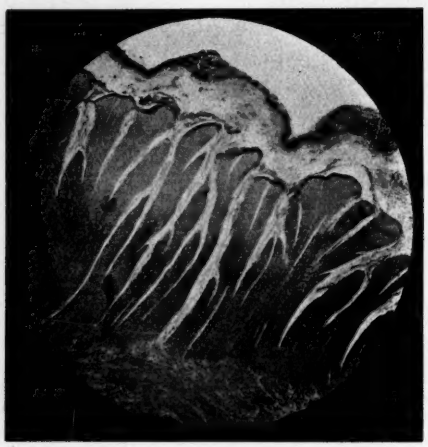

FIG. 194.—Shows submucous layer of considerable extent. Two isolated lymphoid follicles are seen on the lumen surface. (× 7·5.)

FIG. 195.—Shows very great hypertrophy of the circular and longitudinal muscular coats. (× 7·5.)

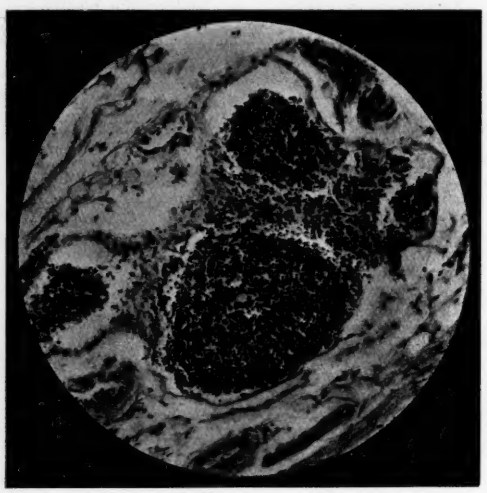

FIG. 196.—Shows a lymph gland in the mesentery of the tumour, also blood-vessels and nerve-fibres. (× 75.)

*Specimen.*—This has all the appearances of a portion of intestine. It is more dilated at one end than at the other and there is some evidence of slight constriction between these two portions. At the broad dilated end there is a rim of what might have been scar tissue, but the appearance is not that of scar when cut

across. A ridge, corresponding doubtless to the mesenteric attachment, runs along the specimen in its long axis and outer aspect. Three portions were taken for microscopic examination, one from either end and one through the mesenteric attachment. Microscopically there is no evidence of cicatricial tissue at either end. The chief features are : (1) An atrophic mucous membrane almost devoid of epithelial covering ; (2) A greatly hypertrophied muscle coat.

In more detail the microscopic characters are : The mucous membrane shows a condensation of cells which has much the appearance of an epithelial covering, but which consists really of reticular epithelioid (connective-tissue) cells, forming a smooth surface layer. Here and there are gland elements of fragmentary character. In their appearance (numerous goblet cells in some cases) they suggest those of large intestine. Small isolated lymphoid follicles are present and extend right to the lumen surface. The cells of this mucous membrane are of reticulum type, connective-tissue cells, lymphoid cells, and eosinophils. A well-marked muscularis mucosæ of two layers, superficial circular and deeper longitudinal, is present (*Fig.* 193). The submucous layer of loose connective tissue, with numerous blood-vessels, is of considerable extent and is separated from the muscular layer by a very condensed fibrous tissue (*Fig.* 194). The circular and longitudinal muscular coats are markedly hypertrophied (*Fig.* 195). In the mesentery there are well-formed blood-vessels, numerous nerve-fibres, and a small lymphatic gland (*Fig.* 196).

In our opinion the tumour undoubtedly belongs to the enterocystomata, which have been described by Roth,[1] Dittrich, Runkel, Rembach, Gfeller, Colmers, Terrier and Lecène,[2] Cautley,[3] and others. It would appear that Roth's studies were confined to enterocystomata of vitelline origin. He describes them as " congenital pouches filled with fluid whose wall possesses more or less perfectly the structure of the intestinal canal ". In enterocystomata of vitelline origin it is only that part of the omphalo-mesenteric duct attached to the intestine which persists, and, becoming cystic, may either still preserve its communication with the lumen of the gut or become completely separated from it. Most authors agree that all enterocystomata cannot be proved to be of vitelline origin, and some hold that certain non-vitelline cysts are teratoid in character. To say that a cyst is non-vitelline because it has developed on the mesenteric border of the intestine or between the leaves of the mesentery would be quite incorrect, for, according to many observers, these are frequent sites, though the antimesenteric border may be the most usual. Again, though the structure is typically that of the small intestine in most cases of vitelline cysts, it would be wrong to assign too much importance to variations in single features, e.g., the mucosa, for it must be remembered that the origin of the cyst dates back to embryonic life when the intestinal epithelium was incompletely differentiated ; thus epithelial polymorphism is easily explained. The rarest type of enterocystoma is that we instance, in which the cyst and normal intestine are connected only by a peritoneal fold or mesentery, no solid or patent intestinal pedicle existing between them. Whatever their origin, all enterocystomata would seem to have certain points in common : viz., etiologically, that they are mostly found in young females ; pathologically, that they are most commonly found in the region of the terminal ileum or in the ileocæcal angle, are unilocular, and filled with a clear, viscous, mucoid liquid. Malignant disease (spindle-celled sarcoma) has been known to invade the cyst wall, and one case is reported where it became infected by tubercle from contact with a loop of tuberculous gut.

**Clinical History.**—These tumours may be symptomless throughout life; some have been accidentally discovered at autopsy. Symptoms, when present, are vague abdominal pain and recurrent attacks of vomiting. Occasionally they cause intestinal obstruction by torsion or by seriously encroaching upon the lumen of the gut (submucous type). They may, occasionally, be palpated as a rounded or elongated tumour. When they have shown malignancy they have been known to cause persistent ascites. A diagnosis is difficult. Symptoms of intestinal obstruction may fill the picture; at other times appendicitis, acute or catarrhal, may be diagnosed. Only laparotomy can disclose the real nature of the disease.

**Treatment.**—In uncomplicated cases the treatment consists of extirpation, which may or may not necessitate resection of a piece of intestine. When the cyst is entirely separated from the bowel and has a mesenteric pedicle, its removal is a very simple surgical procedure, as in our case.

The case we present possesses many features common to the etiology, pathological anatomy, and clinical behaviour of those cysts which have been reported by other surgeons, but we are uncertain whether it is of vitelline origin or not.

**Pain and Vomiting—Disturbed Reflexes.**—We have renewed our interest in the interpretation of the disturbed reflexes of acute abdominal diseases. Referring back to the patient's history we find that all attacks she suffered from the age of 4 to 8 years were marked by severe vomiting, but that only within the last six months had abdominal pain appeared as a symptom and, becoming more severe with each succeeding attack, demanded special treatment, as on the last three or four occasions.

Pain originating in the hollow viscera is of great and abiding interest. It seems to us that, though it is generally believed that the pain of intestinal colic, appendicular colic, etc., is due to severe and prolonged contraction of the plain muscle of the viscus, confusion results in the minds of many who persistently, and with no supporting evidence at all, forsake this definite and proved cause of visceral pain just because a lesion, e.g., an ulcer, happens to be present.

In the enterocystoma under review pain preceded and accompanied the attacks only in the last six months, though painless attacks of severe vomiting had occurred with great regularity for the previous three and a half years. It will be noted from the microphotographs that a great hypertrophy of the muscle coat existed, while the mucous membrane showed a definite atrophy. Both these features were probably progressive. Atrophy of the mucous membrane would result in a reduced power to secrete and most probably to absorb; muscular hypertrophy would increase peristalsis and cause pain.

We have found that a patient who possesses what we term the 'sausage' appendix, i.e., an appendix whose muscular coat is greatly hypertrophied and whose lumen is dilated behind a stricture near the cæcal end of the viscus, suffers much from gastric symptoms, the so-called 'appendix dyspepsia', which, when actual obstruction of the abnormal viscus threatens, amounts to actual and repeated attacks of vomiting. We have been so impressed with our constant operative findings, that if a patient suffering from an acute lesion of the appendix tells us that he or she has vomited repeatedly on the

first day of the disease, we feel confident that on opening the abdomen the 'sausage' appendix will be found. When the appendicular wall becomes gangrenous pain lessens or disappears; this is not because a dead appendix, like a dead foot, causes no pain, as Murphy used to teach; rather is it because the muscle of the appendix has lost its contractility.

In our enterocystoma progressive hypertrophy of the muscle coat had occurred over a period of four years, and thus we seek to explain the increasing severity of the attacks, which, though at first only evidenced by reflex vomiting, were at the later period painful as well. It is perhaps admissible to believe that temporary strong peristalsis of our patient's intestinal tube might be shared by the cystoma, an isolated intestinal segment whose nerve-supply was similar to and connected with that of the normal intestine. A heavy meal, a common error in a child's dietary, might not produce actual colic in the normal gut, but might easily do so in a closed segment whose cavity was distended with fluid and whose wall possessed great muscular hypertrophy. The intervals between the attacks, when no complaints of any kind were made by the young girl, are more difficult to explain than the attacks themselves. The intervals of freedom from abdominal distress that accompany catarrhal appendicitis are explained by the re-establishment of free drainage of appendicular contents into the cæcum. In our case, however, the only diminution of content that could occur would be by absorption via the blood-vessels and lymphatics of the anomalous intestinal wall. Tension of the cyst from increase of content would excite an attack (vomiting and pain) by supplying the stimulus to the hypertrophied muscular coat; relaxation of the cyst wall would act in an opposite manner. The mucous membrane of the cyst was, no doubt, though atrophied and atypical, still to some extent secretory and absorptive; but exactly what stimulated secretion on the one hand, inducing an attack, and absorption on the other, terminating one, it is, in our opinion, impossible to say. Even partial torsion of the whole cystoma is untenable as a cause of the attacks, for we found that the nature of its attachment to the colon and parietal peritoneum laterally would preclude all attempts at torsion. Moreover, the wall and contents of the cyst gave no evidence of either past or recent interference with the blood-supply.

We are indebted to Dr. Harvey, of the Royal College of Physicians Laboratory, Edinburgh, for his report on the specimen and for the microscopic slides. To Mr. Macgregor, our artist friend, we tender our thanks for the drawings.

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[3] CAUTLEY, *Lancet*, 1906, i, 436.
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# CONGENITAL DISLOCATION OF THE HIP: WITH SPECIAL REFERENCE TO THE ANATOMY.

*(Being the Lady Jones Lecture delivered at the University of Liverpool on Feb. 28, 1929.)*

By H. A. T. FAIRBANK,

SENIOR ORTHOPÆDIC SURGEON AT KING'S COLLEGE HOSPITAL, LONDON.

ALTHOUGH congenital dislocation of the hip is not nearly so common in this country as it is in certain parts of France and Italy, we meet it here sufficiently often to make it a subject both of interest and importance. In spite of the fact that for many years past an increasing amount of attention has been paid to this deformity by surgeons throughout the world, there is still no general agreement as to the treatment, which must necessarily vary with the age of the patient. A great deal can be found in medical literature about the anatomy of this affection, but there are details which appear to have been overlooked, and others, I venture to think, which have not received the attention they seem to deserve. This paper is a review of the subject from the anatomical aspect, and then discusses the bearing that the facts presented have on the treatment.

## ANATOMY OF THE NORMAL HIP.

To turn for a moment to the normal anatomy of the hip-joint: if the neck of the adult femur is looked at from the front, there is often apparent a faint ridge, more marked above than below; this divides the surface into an inner rough and an outer smooth area, the latter being grooved. Walmsley[1] named this ridge 'the capsular ridge', and compared the groove external to it with a pulley, and called it 'the capsular groove'. In contact with this groove is the supero-lateral portion of the capsule, which is under greatest tension, he says, in full extension of the joint.

The angle formed by the axis of the head and neck with that of the shaft—the 'angle of inclination', as it is called—is about 125°, or slightly more in children, but it may vary considerably in apparently normal hips. The angle of anteversion, or antetorsion, which is the angle the axis of the neck makes with the transcondylar line, shows even greater variation in hips which display no sign of instability. Pearson[2] gives the mean figure for this angle as 15·3°, while Burghard[3] says it varies from 15° to 25°. Soutter and Bradford[4], in 154 normal femora, found the angle varied from 37° to −25°, with an average of 14·3°. Mikulicz[5] gives the average figure as 11·6°, while Durham,[6] in 200 femora, found the angle varied from 0° to 35°, with an average of 11·9°. He argued that anything up to 35°, even in a dislocated hip, might be disregarded.

Of the muscles, the only group I need mention consists of the two obturators, the gemelli, and the quadratus, which pass practically horizontally

outwards to the femur. Besides their obvious use as external rotators, it seems highly probable that they serve a useful purpose in keeping the head of the femur pressed home in its socket.

## ANATOMY OF THE DISLOCATED HIP.

With these few remarks I pass to the consideration of the modifications of the normal anatomy met with in the presence of a congenital dislocation of the head of the femur. The statements I venture to make are founded on a study of 35 museum specimens, comprising 46 dislocated hips; an experience of some 50 open operations on cases of this deformity (in 26 of which the joint was opened); and a perusal of much of the extensive literature in which are found many observations on the anatomy. The scarcity of museum specimens of young subjects is to some extent compensated for by the fact that research on the living is largely confined to the young.

FIG. 197.—Fœtus of 5½ months. Note rounded postero-superior margin of acetabulum with extension of joint behind as well as above this. (*After Van Neck.*)

### THE BONES.

**The Os Innominatum.**—We may begin with the os innominatum, since the source of all the trouble undoubtedly lies in the acetabulum. If a fœtal specimen be examined, the most striking, and often the only, feature besides the slight displacement of the head of the femur is the poor development of the upper margin of the acetabulum (*Fig.* 197). This is the primary fault, to which all the other changes are secondary. Slight laxity of the capsule

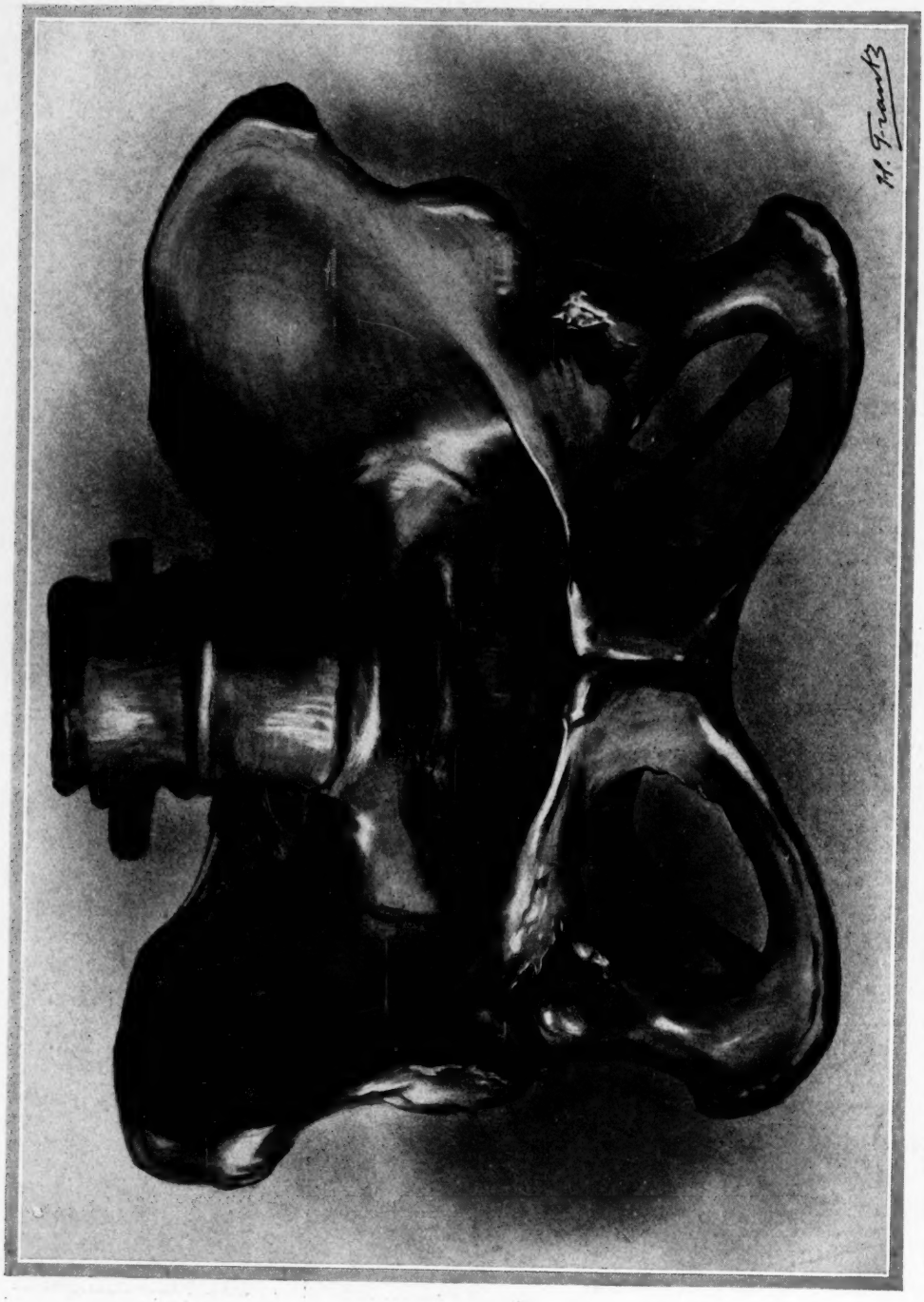

FIG. 198.—Note obliteration of acetabulum by overgrowth of ischium, which forms a tubercle on each side. (*Musée Dupuytren* 742.)

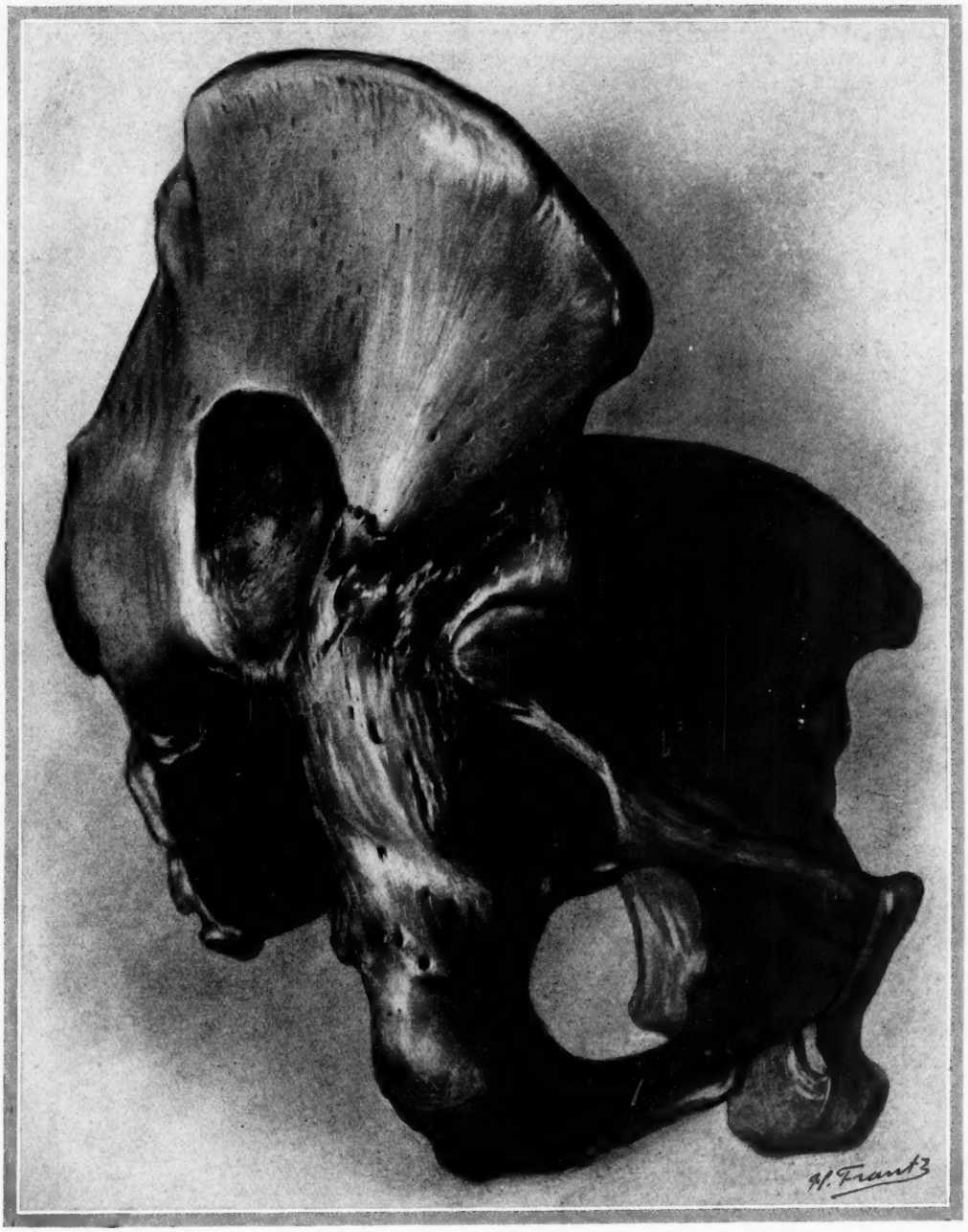

FIG. 199.—Note triangular acetabulum; well-marked retro-acetabular impression; groove for psoas, and shallow false acetabulum. (*Musée Dupuytren* 745. R. side.)

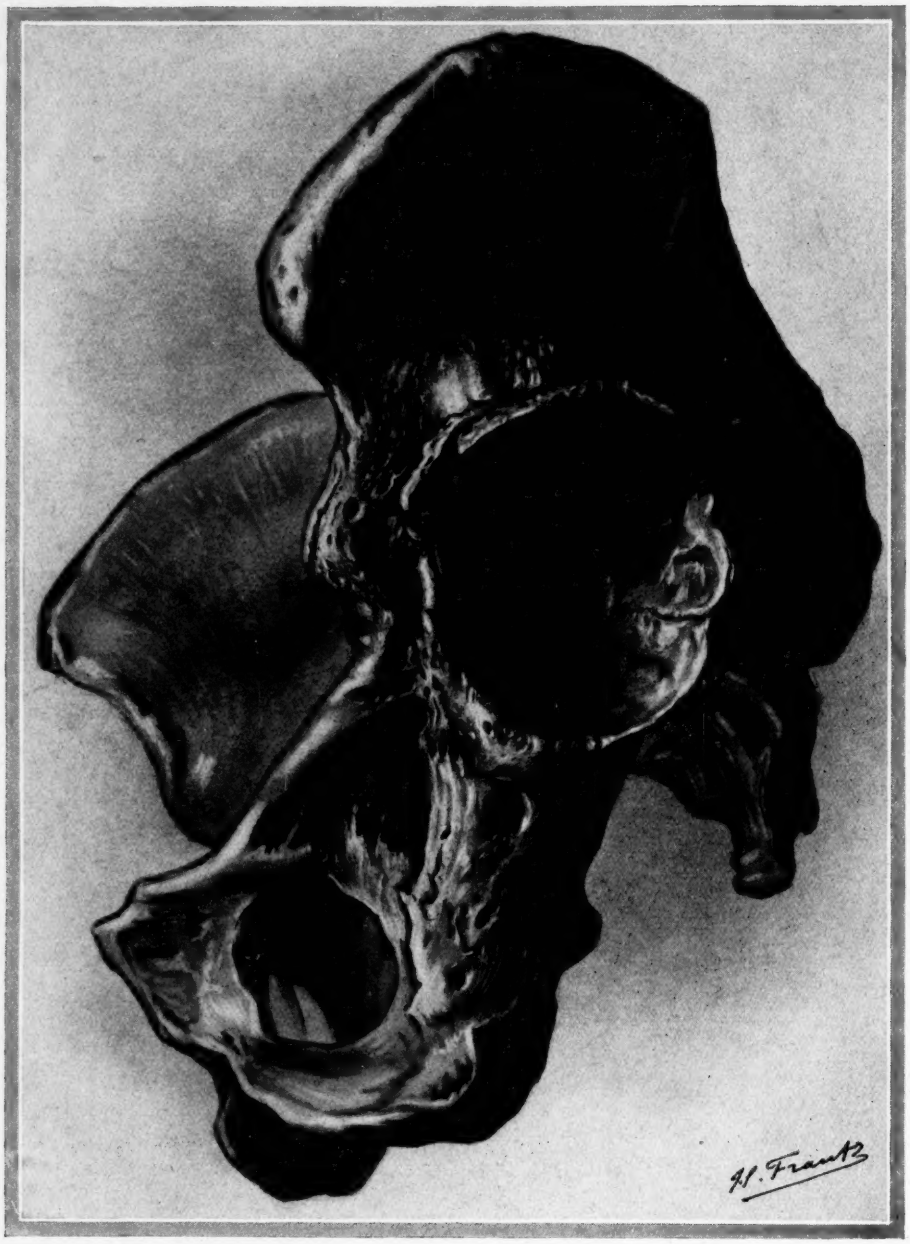

FIG. 200.—Left side of pelvis shown in *Fig.* 199. Note deep false acetabulum, the result of advanced osteo-arthritis.

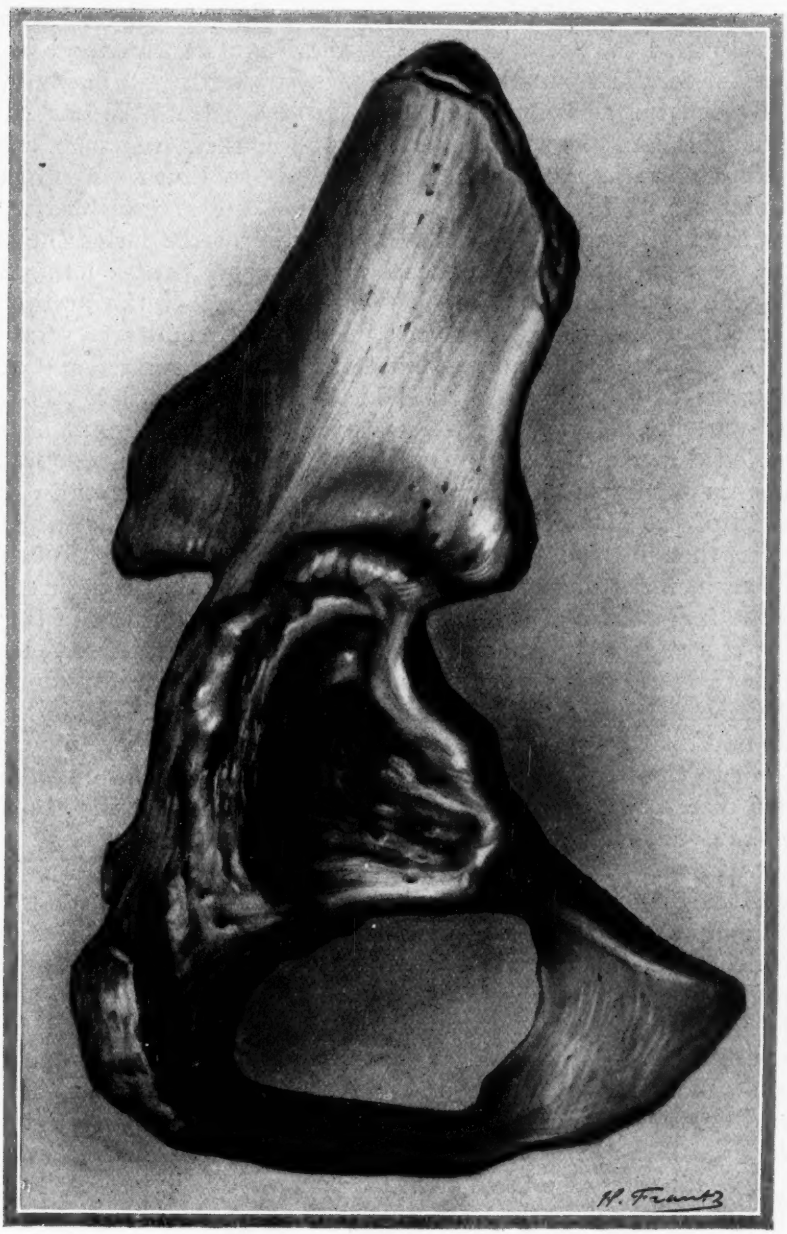

FIG. 201.—Note well-marked auricular retro-acetabular impression. Deep groove for psoas. No sign of false acetabulum. (*Musée Dupuytren* 740A.)

may be present, a point very difficult to make sure of, but even this may well be secondary. The malformation involves not only the cotyloid ligament, but also the cartilaginous margin, and even the bone—as may be clearly seen in radiograms taken within a few months of birth. Before many years have passed the acetabulum becomes triangular, with the base towards the obturator foramen and the apex pointing upwards and backwards. One specimen estimated as being about 9 years of age has a distinct suggestion of this triangulation. Bowlby[7] reported a well-marked triangular acetabulum at 13 years. This triangulation is the result of the continued growth, unchecked by the pressure of the head of the femur, of the antero-superior and the posterior boundaries of the socket. In the case of the latter the growth is excessive, in response to the unusual stresses and strains induced by the dislocation, as will be shown later. These margins of the acetabulum are usually straight and sharp, and not uncommonly undercut. In the vast majority of the dry specimens examined the cavity is surprisingly deep, even up to the age of 60 years, but the floor is more or less flat. The edges in some cases are lipped, especially the posterior, which may overhang the cavity to a marked degree. The transverse ligament may be ossified. In the fresh specimens the cavity is to a large extent filled by cartilage and a fibro-fatty overgrowth of the Haversian gland. Hoffa[8] said there was always cartilage in the floor, though this might be covered with fibrous tissue. In one remarkable specimen, unfortunately lacking the femora, in the Dupuytren Museum in Paris, both acetabula are practically filled by an overgrowth of the ischium, which forms a nodule on each side (*Fig.* 198). The obturator foramen is more triangular than normal; the pubic angle is increased; the ilium is shorter and broader than normal; and the anterior border is prolonged in the vertical direction and displays a wavy outline. The anterior inferior spine is twisted to conform to this outline, being convex inwards above and outwards below, the latter corresponding to a well-marked groove for the ilio-psoas tendon.

On the dorsum ilii, in adolescents and adults, there is usually something to be seen in the way of a false acetabulum. Even in adults this may be nothing more than a shallow pond, more or less circular, with but a faint rounded margin. As a rule this pond is considerably larger than the femoral head, which rests in or against it, and this disproportion in size suggests there must be considerable mobility of the femur, in an antero-posterior as well as a vertical direction. It may show one or more raised flat-topped bosses, with smooth, eburnated surfaces (*see Fig.* 208). In some cases the edges are well developed, while occasionally a deep hemispherical cup with a polished eburnated floor is seen. Such a well-formed false joint is clearly the result of osteo-arthritis, and is associated with similar changes in the femur. In a bilateral case these arthritic changes may be present to a marked degree on one side while they are entirely absent on the other (*Figs.* 199, 200). The false acetabulum may be represented by a large facet, slightly hollowed and raised above the level of the surrounding bone, and with a polished surface and sharp edges (*see Fig.* 202). In situation it may be high or low, more anterior, or far back close to the great sciatic notch. In some it is difficult to determine where the head rested, unless against an area of thickened bone just above and behind the acetabulum; this may or may

not be continuous with the rough impression on the ischium shortly to be described.

Of 38 hips in which a visible false acetabulum was expected, it was a mere shallow hollow with little or no margin in nearly half (17). In 9 specimens there was no sign of a false joint, while in 9 a well-marked arthritic socket, with lipped margins and an eburnated floor, was present. In one case the ilium showed facets but no hollow.

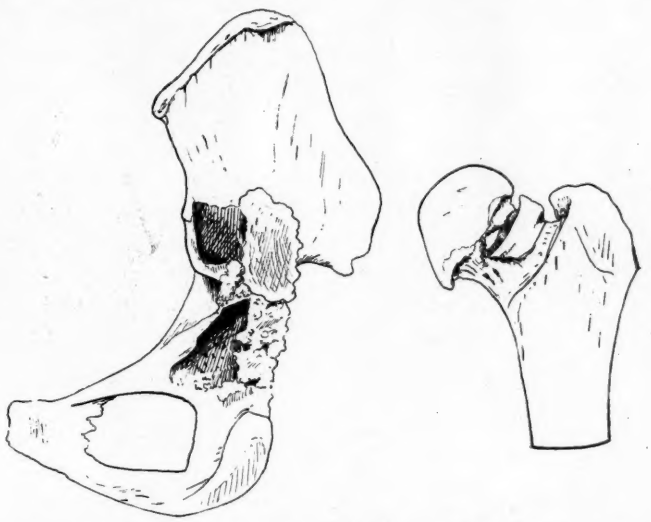

FIG. 202.—Note false acetabulum, a slightly hollow, raised facet. Retro-acetabular impression shows polished, pitted surface with sharp margins, encroaching somewhat on acetabulum. Deep hollow between inferior iliac spine and false acetabulum. Femur shows raised facet on neck. Slight lipping of head. (*Musée Dupuytren* 749B.)

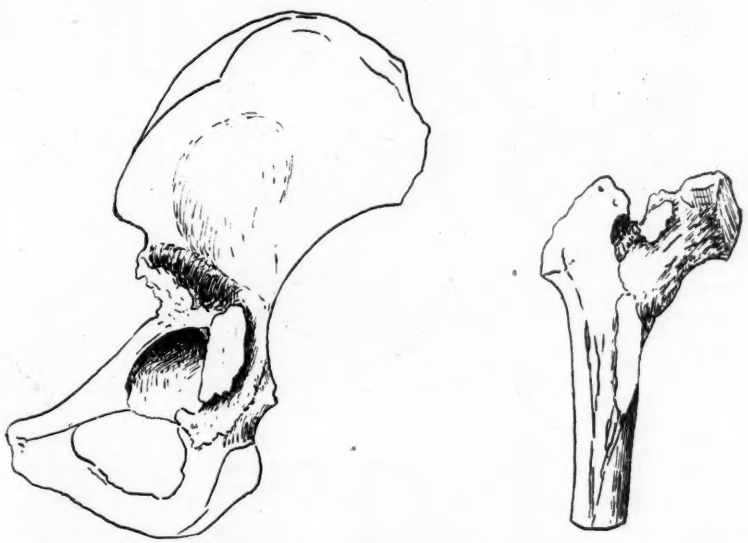

FIG. 203.—Note retro-acetabular facet, slightly overlapping acetabulum. False acetabulum shallow, but extensive, with deep groove below it. Femur shows flattening of head, two facets on neck, and facet replacing lesser trochanter. (*Musée Dupuytren* 757P.)

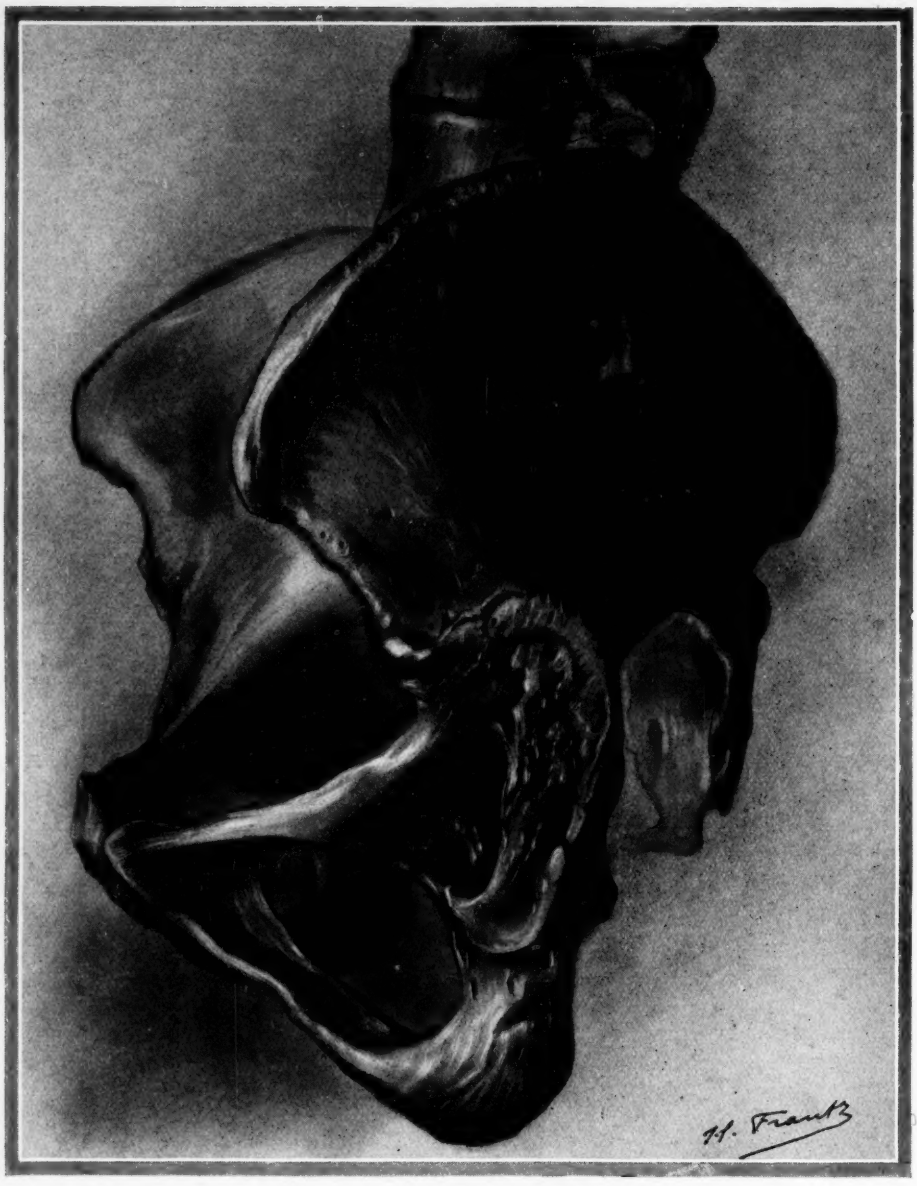

FIG. 204.—Note well-marked auricular retro-acetabular impression. No sign of false acetabulum. (*Musée Dupuytren* 747F.)

The ischium shows perhaps the most remarkable changes of any of the bones, yet it has received but scant attention from surgeons. It is usually said that the tuber ischii is everted, but this is hardly an accurate description of the changes found. On looking at the bone that lies behind the acetabulum, formed by the ischium below and ilium above, in most adult cases we find the normal smooth, slightly convex surface profoundly changed. It may be simply roughened, with many pits, ridges, and nodules; it may be raised into a definite ridge with a similar roughened surface; while it may present a raised articular facet with a smooth polished surface of varying size (*Figs.* 201, 202, 203).

In 8 of the 36 specimens in which this area was exposed there was nothing very remarkable about the bone. In all the remaining 28, however, notable changes had taken place. In 8 what may be termed the retro-acetabular impression showed an unusually roughened surface; in 9 a definite broad ridge was seen; while in 8—with the possible addition of a ninth—there was a facet.

As will be seen later, the joint cavity overlaps this surface, and this extension might account for the striking smoothness noticed in a few specimens (3). The excessive roughness and the thickening of the bone are due, I suggest, to the excessive strain that has to be borne by the hypertrophied ischio-capsular ligament, which is here attached. The facet, when present, is due to pressure and friction against the lesser trochanter, which shows similar changes. The 'impression', whether only roughened or ridged as well, may extend above and forwards over the top of the joint to form an auricular shaped surface (*Fig.* 204). When this auricular impression is seen it seems possible—even probable—that the head of the femur had rested opposite the upper part of it, since no sign of a false acetabulum is found higher up. When facets are present on the pelvis and femora these have not necessarily been in direct contact—in fact, in most cases, and perhaps in all, the capsule has intervened between the bones. As I hope to show presently, the postero-inferior portion of the capsule is not attached close to the acetabular margin, but some distance farther back—in some even as far back as the posterior margin of the retro-acetabular impression. The ischial facets are in front of the capsular attachment and are therefore within the joint cavity. The facets are usually single, but in the Royal College of Surgeons Museum is a specimen showing three. In size they may be as small as a sixpence, while the largest seen measured $2\frac{1}{4}$ by $1\frac{1}{2}$ in. In this case the facet has spread forwards over most of the old acetabulum (*see Fig.* 210).

**The Femur.**—Even in young children the head is smaller than normal, though relatively large compared with the acetabulum, while the ossific centre is late in its appearance, and smaller than that of the normal femur. Before long the head becomes flattened by pressure against the ilium on its inner and posterior aspect, while less commonly it is also flattened in front and on top. The head then suggests a wedge rather than a cone, the edge of the wedge lying in a plane which runs downwards and forwards (*Fig.* 205). A conical head may be seen, but is rather less common. Bowlby[9] described such a head, the apex of the cone corresponding to the stump of the

ligamentum teres, which had disappeared. In some cases, and particularly in adults, much greater changes are seen: these are of two kinds—namely, erosion and lipping—either of which may predominate. The amount of erosion varies from a slight pitting of the cartilage surface to complete disappearance of the head. After much forcible manipulation pitting has been met with in a case only 4 years of age. Lipping may be seen at the lower margin only of a conical or otherwise misshapen head, while it may produce a typical mushroomed head with little or no erosion. When combined with erosion and

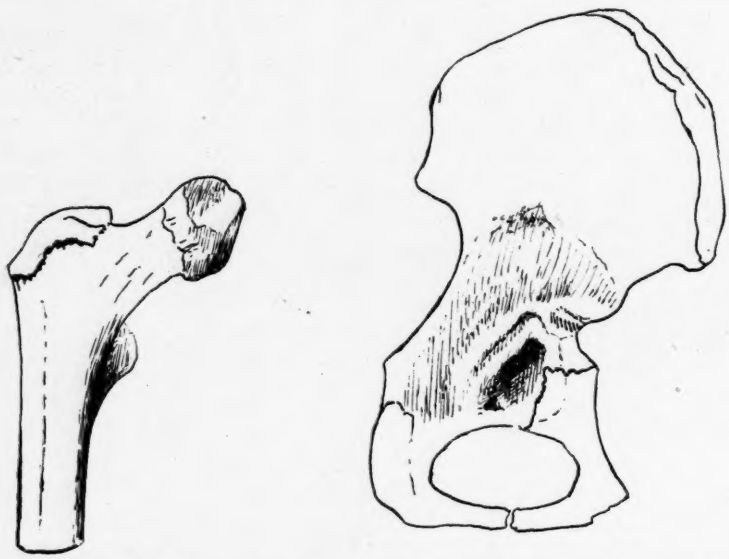

FIG. 205.—Pelvis shows very shallow acetabulum, with rounded margin, and above and behind it an extensive auricular impression. Femur shows a well-marked wedge-shaped head. (*Musée Dupuytren* 739A.)

eburnation it produced the appearances characteristic of advanced osteo-arthritis. In adults one is sometimes surprised by the rounded contour of the head as seen in a radiogram, though it is common enough in such cases to see the head reduced to an irregular knob much smaller than the normal (*Fig.* 206). Bradford and others[10] found flattening of the head present in all cases of 10 years and upwards. Gill,[11] in the light of his operative experience, says the cartilage is loosely attached to the bone and easily detached by force even against the acetabular margin.

As to the museum specimens: in most of the youngest, as well as in 2 of the adults, the head was of fairly good shape; 5 showed wedging as against 4 with a conical head; in one the head was flat above and inside; 10 showed marked irregularity in shape and lipping; 5 showed advanced erosion; in over half (17) there were definite signs of arthritis of some kind.

In two femora with conical heads was seen a curious circular groove running at right angles to the axis of the cone, and presumably due to pressure by a fold or ridge in the capsule (*Fig.* 207).

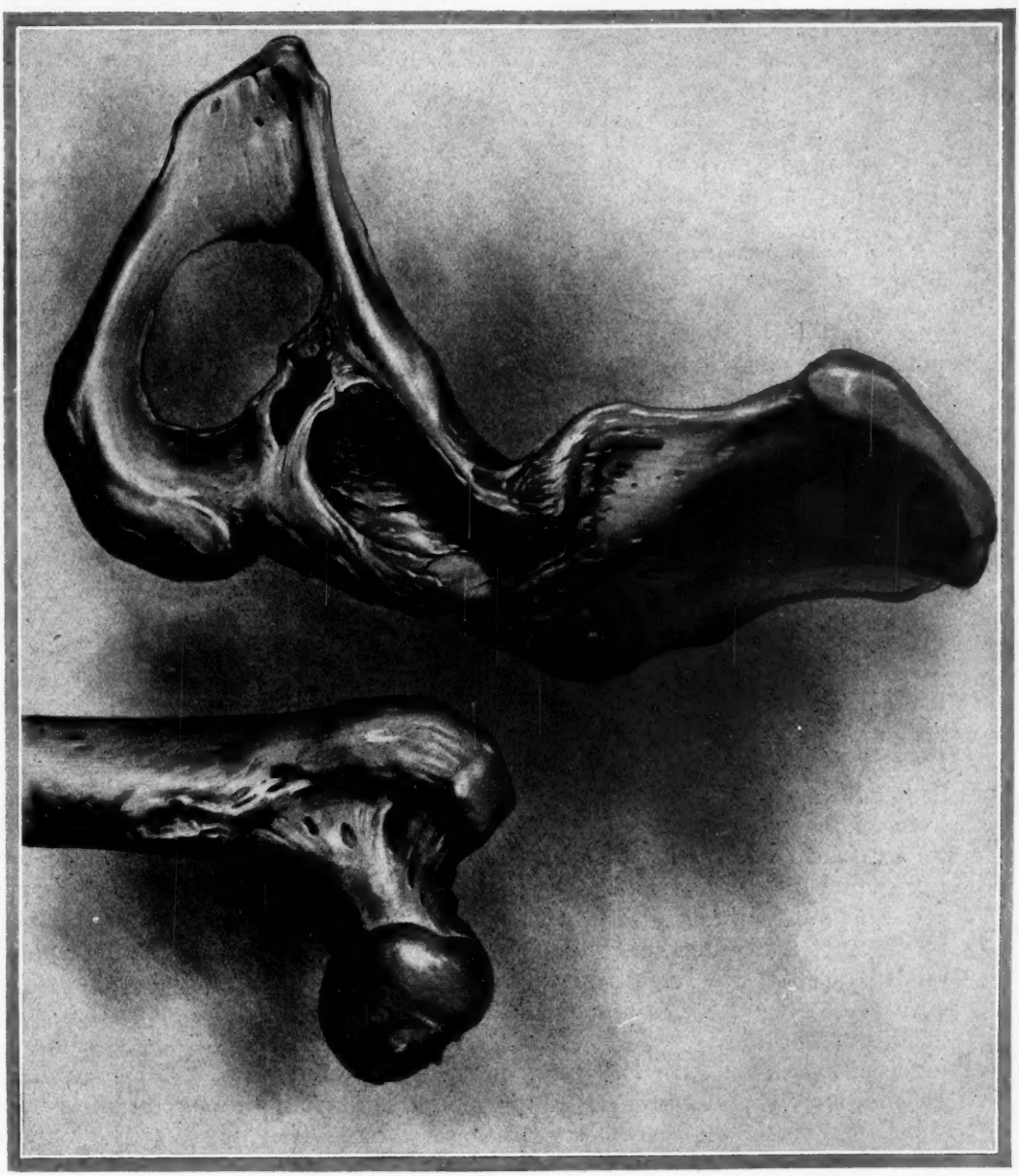

FIG. 206.—Acetabulum prolonged upwards as a groove surrounded by roughened bone. Retro-acetabular impression shows roughness typical of ligamentous strain. Transverse ligament ossified. (*Musée Dupuytren* 745B.)

The neck of the femur may be normal in length, but is often short and slender. The older the patient the less likely is the neck to be normal, not only as to its length, but in other ways. Coxa valga, often more apparent than real in a radiogram, may be present, but coxa vara is much more frequently met with, though not so commonly before as after reduction. Of 32 femora of all ages examined regarding this point, only 9 showed definite coxa vara; the worst of these showed a right-angle deformity.

FIG. 207.—Note circular groove on femoral heads. (*Musée Dupuytren* 741A and 748.)

As to antetorsion, stress has been laid on this by most writers, many attributing their failure to maintain reduction in some cases to the presence of this deformity. Farrell, von Larkum, and Smith,[12] by taking radiograms in the neutral and the fully inverted positions, estimated the antetorsion in 336 cases. In nearly half the angle was over 20°; of these about half gave an angle of 20° to 50°, while in the remainder, i.e., nearly a quarter of the whole, the angle was over 50°. While admitting the great difficulty of accurate estimation, they conclude that antetorsion is a factor of considerable importance. On the other hand, in 1000 cases, Froelich[13] found an extreme degree of antetorsion in only 1 per cent. Whitman[14] suggests that an angle of 35° is normal at birth, and that this is gradually reduced, by tension of the capsule, to 15° to 10°. If the hip is dislocated, this reduction does not take place. My own impression is that while an angle above the normal is extremely common—almost the rule—extreme degrees of antetorsion rendering permanent reduction an impossibility are rare. In one remarkable case met with at the age of 9, with $2\frac{1}{2}$ in. of shortening, *retro*torsion was present, the head lying behind the trochanter. This patient only commenced to walk in her fifth year. The accurate estimation of the angle of antetorsion in the living subject is a matter of considerable difficulty. I am greatly indebted to my friends, Drs. Shires and Graham Hodgson, for the trouble they have taken to help me in this matter.

The most promising method for research seems to be that suggested by Stewart and Karshner,[15] though this has the disadvantage of depending on the use of the screen, in a darkened room. The patient lies prone, with the knee on the affected side flexed to a right angle, and the tibia vertical. The foot is carried over towards the sound side, i.e., the femur is externally rotated until the head, neck, and shaft appear to be in a line. By means of a graduated arc and pointer this angle is measured; the result subtracted from 90 gives the angle of antetorsion. They say that the margin of error is not more than 5°.

In the 26 museum specimens in which this could be noted, only the upper few inches of the femur being available in most, the angle of antetorsion was estimated as varying between 0° (3 cases) and 75° (1 case). In no fewer than 11 the angle was about 45°, while the average worked out at 30·6°—not a very high angle, be it noted.

A feature of considerable interest is the finding of smooth polished facets on the neck of the femur. These I found on 7 femora, in 2 of which two separate facets were seen, one in front and the other behind, close to the

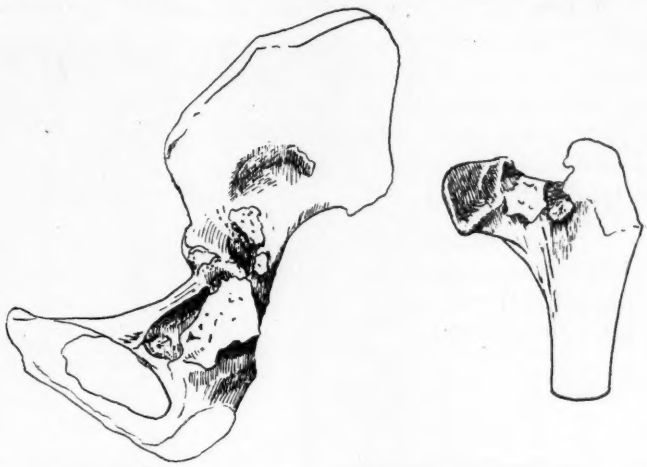

FIG. 208.—Note retro-acetabular facet overlapping acetabulum. Raised facets in floor of false acetabulum. Femur shows conical head, facet on neck, and pronounced tubercle on anterior inter-trochanteric line. (*Musée Dupuytren* 749C.)

upper surface of the neck. In the other 5 only one facet was present, and this was situated high up on the anterior surface; in 3 of these it extended on to the superior surface. The facets are not extensions from the head, but are quite separate from it (*see Figs.* 202, 203, 208). They were raised above

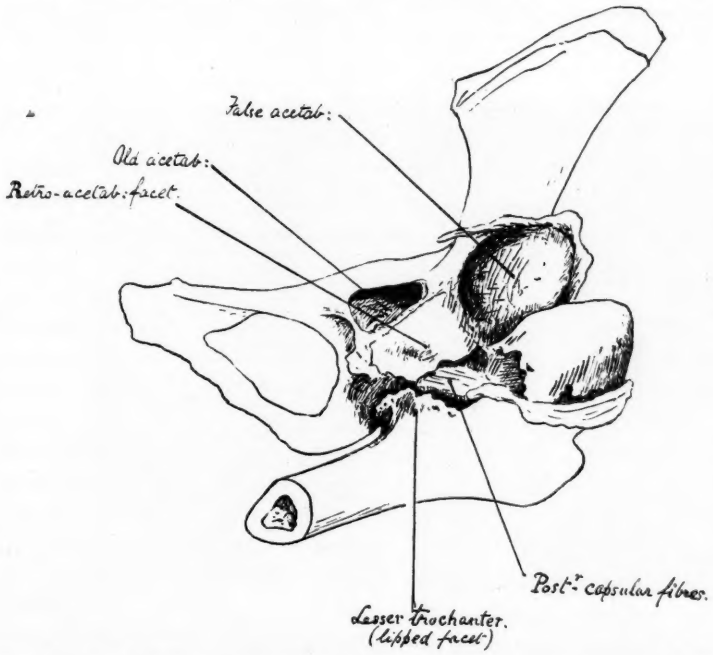


FIG. 209.—Note large retro-acetabular facet with ischio-capsular band attached *behind* it. Acetabulum shows sharp margins and ossified transverse ligament. False acetabulum and head of femur show marked osteo-arthritic changes. Lesser trochanter shows lipped facet. (*Musée Dupuytren* 746.)

the level of the surrounding bone—in some cases markedly so—and from their shape and grooved surface unquestionably took the strain of the capsular sling. In other specimens, devoid of facets, the grooving of the neck above was at least suggestive of unusual pressure.

In some femora (7 in this series) the tubercle near the upper end of the anterior intertrochanteric line, for the attachment of the iliotrochanteric band, was particularly well developed (*Fig.* 208); in others it was entirely absent.

While in children the lesser trochanter is normal, in adults it may show most striking changes. It may be entirely absent, be represented by a flat elongated area with a faint raised margin, or finally it may be well formed but have at its apex a flat facet. This facet may have a smooth eburnated surface, with an overhanging lipped margin, and varies considerably in size. In those showing the largest facets, the process is much elongated in the vertical direction (*see Figs.* 203, 209, 210).

Our findings in the museum specimens were as follows: normal in 12; facet present in 8, possibly 9; entirely absent in 1; very prominent and lipped without definite facet in 2; and situated abnormally low in 1. Six specimens were too young to show any change.

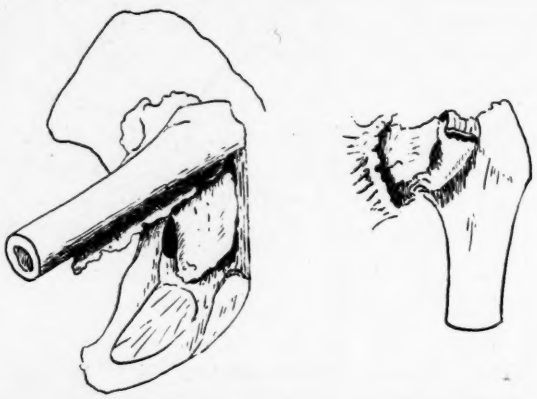

FIG. 210.—Note extremely extensive facets behind acetabulum and on lesser trochanter, and the presence of capsule behind the facet on ischium. False acetabulum and femur show marked osteo-arthritic changes. A portion of capsule has been left arching over neck of femur (capsular sling). (*Musée Dupuytren* 753C.)

As a rule if there is a facet behind the acetabulum, there is a corresponding facet on the lesser trochanter, but in one bilateral case in the Dupuytren Museum the femora show facets while there are only well-marked ridges, without facets, on the pelvis.

*X-ray Evidence.*—After childhood the development of the retro-acetabular ridge and the presence of facets at this spot and on the lesser trochanter can often be seen in the radiograms of untreated cases, and also in many where relapse, partial or complete, has followed reduction (*Fig.* 211). At first it was thought these facets would only be found in the presence of adduction deformity, but this proves to be incorrect, for recently a case was seen with a full range of abduction, and yet well-marked facets were shown in the radiogram. As a sign of instability after apparently successful treatment, thickening of the ischium is of considerable value, but cannot be relied on absolutely. Though to be seen in most cases showing imperfect acetabula, it is occasionally absent when the joint is obviously unstable or even subluxated. Two other anatomical peculiarities have been revealed by X-ray examination. The first is a loose fragment of bone, not unlike a sesamoid, at the back part of the tuber ischii. This has been met with three times: the origin of this fragment is doubtful, and may not be the same in each case

(*Figs.* 211, 212). The second, seen in a few cases, is a prominent tuberele situated a little below the level of the upper lip of the acetabulum (*Fig.* 213). This seems to be an outgrowth of the posterior margin of the socket.

FIG. 211.—Radiogram of left hip of woman of 26 (unsuccessful reduction at age of 5). Note facets on pelvis and lesser trochanter. Ischial tuberosity shows loose bony fragment.

FIG. 212.—Radiogram of bilateral dislocation. Woman of 21 years. Reduction at age of 5. Note ischial projection with large loose fragment on left.

The bones of the leg may be either shorter or longer than those of the opposite limb. As much as half an inch of shortening has been noted between the tip of the trochanter and the external malleolus before reduction,

while the foot is frequently smaller than its fellow. On the other hand the shortening, as measured in the usual way, may be less than the radiogram would lead one to expect. A boy of 10 with a subluxation of the hip showed the affected leg nearly half an inch longer than the other. After successful reduction we have found the limb longer than the other in many cases, the greatest difference noted being three-quarters of an inch ten years later.

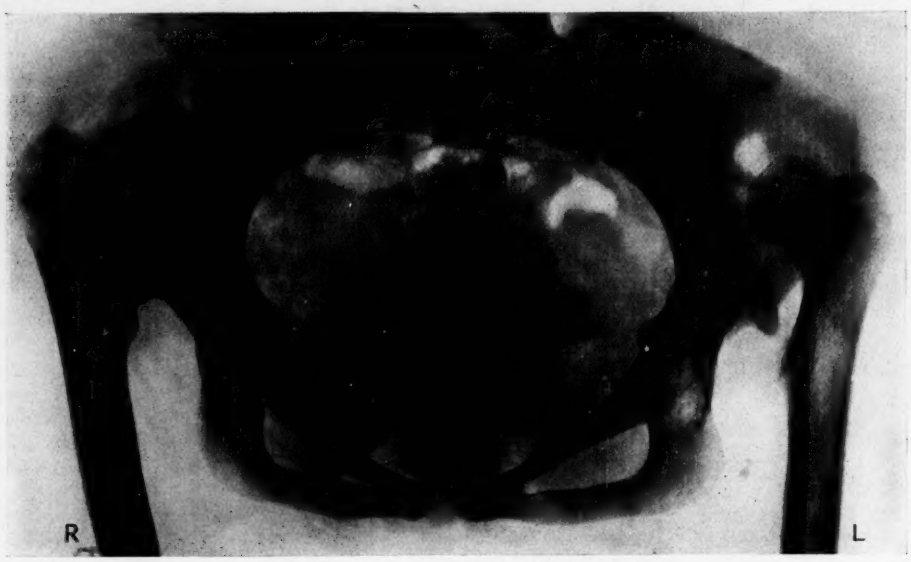


FIG. 213.—Bilateral dislocation, girl of 12 years, untreated. Note tubercle on each side just below level of upper acetabular margin.

**The Capsule.**—The general arrangement of the capsule has been well known for many years. As the head migrates upwards it carries in front of it a dome of the capsule which blends with the periosteum above and behind the acetabulum. Where this fusion occurs in the floor of the false acetabulum, the two are transformed into fibrocartilage. In response to the abnormal strain to which it is subjected, the capsule, though lax and thin at first, becomes thickened, the thickness attained varying considerably in the different portions of the capsule and in different cases. It may be as much as a third of an inch in thickness in a child of 13 years. It is generally said to be thickened in front, the part, be it noted, where it is almost invariably incised by the surgeon. The presence of a well-marked tubercle on the front of the femur suggests great strength in the iliotrochanteric band. It is particularly strong below, where it is often divided by the surgeon to enlarge the isthmus, and where it is in close relation to the psoas tendon. Bradford[16] noted the strong bands passing to the lower part of the neck and the region of the lesser trochanter. The ischiocapsular band behind is always thickened, and is, I believe, of special importance. Shattock[17] described it as 'specially strong', while Bennett,[18] in one case, found the posterior capsule cut like fibrocartilage. As already stated, this band is attached, not close to the posterior margin of the acetabulum, but some distance behind it, and rather

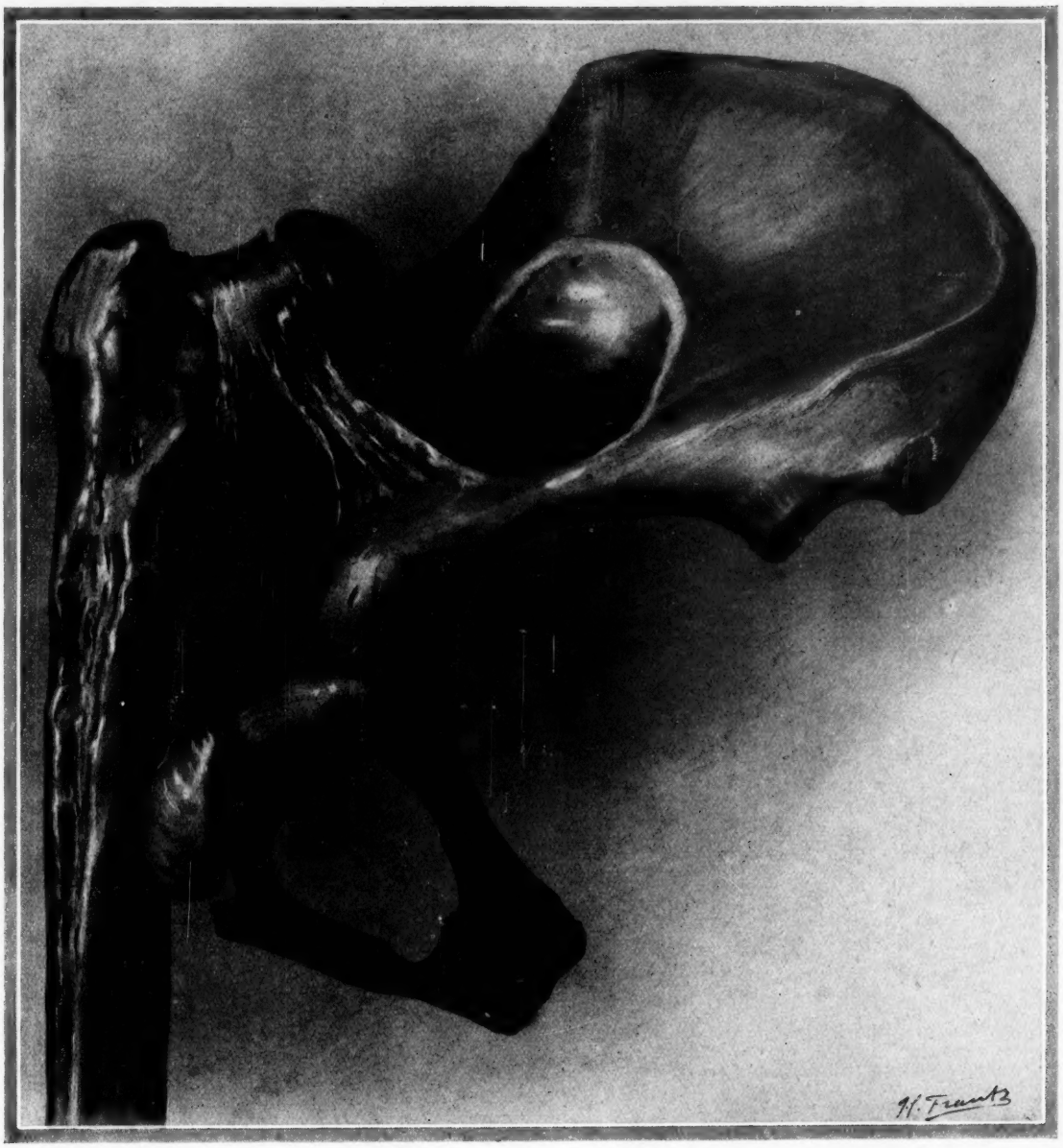

FIG. 214.—Capsular sling has been left in place. Note capsular isthmus adjacent to femoral neck and drawn well away from pelvis. (*Musée Dupuytren* 749.)

obliquely, and when a retro-acetabular facet is present the attachment is along its posterior margin (*see Fig.* 209). These ischio-capsular fibres, much increased in numbers, pass upwards to arch over the neck of the femur and blend with the strong fibres in front that are attached to the anterior margin of the acetabulum and transverse ligament. In this way is formed a powerful sling which passes over the neck as over a pulley, and prevents further upward displacement of the femur (*see Figs.* 210, 214, 220). Whether plaques of bone or cartilage are ever formed in this capsular sling to correspond to the facets noted on the femur we have been unable to discover. Though the capsule lying over the neck is always thickened, and that over the head generally so, this is not invariably the case. In a young woman operated upon at 24 years, the capsule hardly existed over the head, where the reflected head of the rectus blended with it.

The ligamentum teres is usually present in young children, and frequently absent in the older cases. Increased age, greater displacement of the femur, and previous manipulative treatment are three factors that contribute to its disappearance. Hoffa[19] found it absent in 27 per cent of 200 cases, while Galloway[20] found it surprisingly large in cases not previously manipulated, and usually absent after this method of treatment had been tried. In the majority of cases the ligamentum teres is of no importance whatsoever, but occasionally it is of sufficient size to interfere materially with satisfactory reduction. In a child of only $2\frac{1}{4}$ years it formed a slab $\frac{5}{8}$ in. wide and $\frac{1}{8}$ in. thick, and this interfered with stable reduction.

The hour-glass shape of the joint cavity is well known and needs no special description. Hoffa[21] was the first to note the importance of the psoas tendon in accentuating the so-called isthmus between the true and false joints. It is sometimes forgotten that a well-marked isthmus can only be present when the head is completely dislocated, and must therefore be rare in the younger children. Only once have I seen a well-marked isthmus under three years of age.

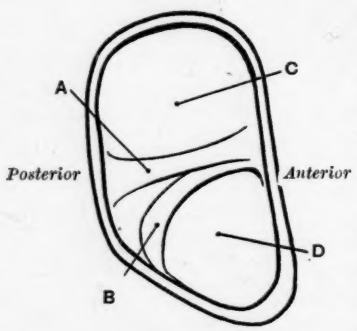


FIG. 215.—Diagram of arrangement of acetabulum on right side of bilateral case, age 4 years, to show capsular fold which descends in front of head during attempted reduction.

A, Fold of capsule; B, Cartilaginous margin of acetabulum; C, False acetabulum; D, Acetabulum.

Now the cavity always extends to some degree backwards over the retro-acetabular impression. In the fœtus this is easily explained by the size of the head from before back, its undue mobility, and the fact that as yet the displacement is slight. But why should this arrangement persist into adult life, as it certainly does in some cases, if not in all? There may be quite a definite sharp fold of synovial membrane, placed vertically and standing up into the cavity between the acetabulum proper and the retro-acetabular smooth area (*see Fig.* 217). This fold corresponds in position to the rounded posterior margin of the acetabulum in young children. It was seen in some of the museum specimens, but only once during an operation, and then, curiously enough, in a child of only 20 months whose hip was opened for

persistent relapse after reduction and fixation. On the posterior wall of the joint in this case was seen a vertical white band. But there is another fold which I believe has never been described, and which was first noted in a bilateral case, the patient being 4 years old. This fold, as can be seen in the diagram (*Fig.* 215), lies more or less horizontally, but is inclined slightly downwards as well as backwards, and is situated just above the position of the upper acetabular margin. It may be pale and yellow in colour, or red if the joint is inflamed. It is soft and not cartilaginous, and is, in fact, a fold of the synovial membrane and capsule just above the acetabulum. When weight is borne on the leg the capsule and synovial membrane are put on the stretch above, and the fold disappears, only to reappear as the tension is relieved. When, during attempts at reduction, the head is forced down

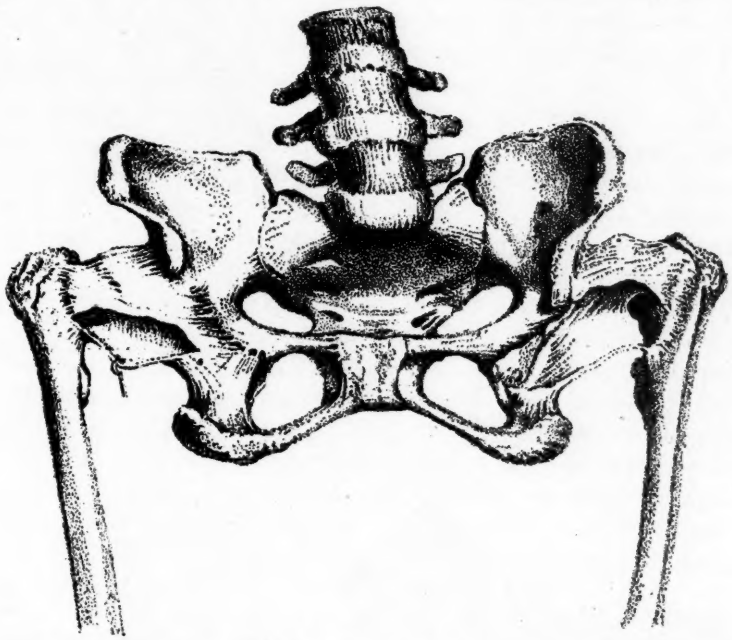

FIG. 216.—Illustration in Carnochan's book. Bilateral dislocation showing isthmus close to femur and bounded on inner side by fold stretching out from pelvis.

towards the socket, this fold is piled up on the acetabular margin and increases the difficulty of forcing the head over it, a difficulty that might be lessened by lifting or pushing the head towards the socket as opposed to levering it in. Z. B. Adams[22] mentions a band seen deep in the socket at the back, which he thinks was " possibly a thickened cotyloid ligament folded in before the head at the first reduction ". It is possible that he is referring to a fold similar to that described above. Unfortunately in comparatively few museum specimens is much of the capsule present, and even in these it is usually dried, but in a few may be seen a fold standing out boldly, and presenting a crescentic outer margin which bounds the isthmus on its inner side (*Figs.* 214, 216, 217). In these specimens, in which it is admitted the femur has been drawn somewhat away from the pelvis, the isthmus lies close to the femur, and

not, as might have been expected, close to the ilium. One of Carnochan's[23] illustrations (*Fig.* 216), the bones of which specimen are preserved in the Museum of the Royal College of Surgeons, shows this condition on both sides. It is suggested that this fold with the crescentic margin is an accentuation of that observed in childhood. The cavity of the joint may be said, therefore, to consist of three portions, one corresponding to the old acetabulum, another over the anterior and upper part of the retro-acetabular bone and separated from the first by a vertical fold, and a third, above, corresponding to and enclosing the displaced head of the femur (*Figs.* 217, 218). During manipulative reduction the head of the femur traverses the second or retro-acetabular compartment, on its way from the third to the first. If the isthmus is very small, the highest compartment may be almost shut off from the other two. One specimen in the Dupuytren Museum, collected by Broca in 1848, shows the joint cavity completely divided into two.

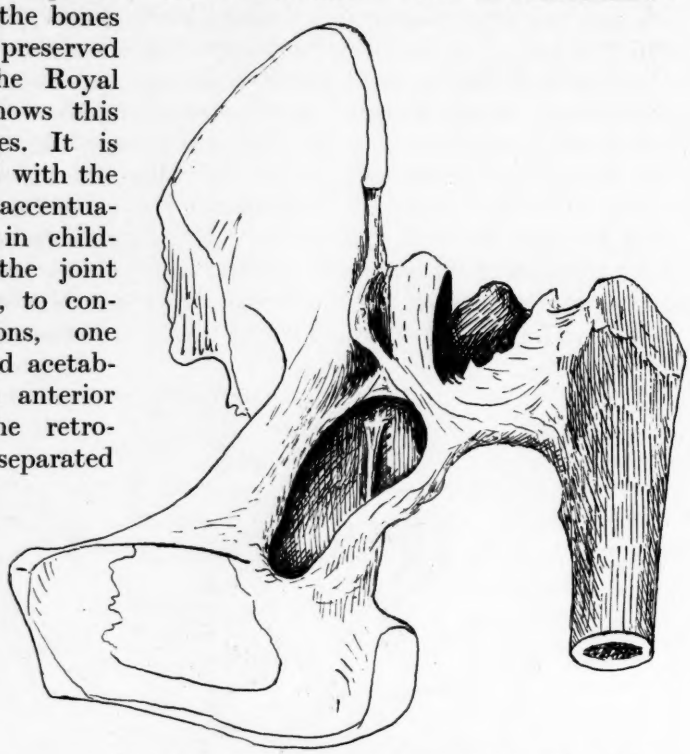

FIG. 217.—Dry specimen with windows cut in capsule. Note vertical fold between true acetabulum and retro-acetabular surface, and, above and outside this, capsular isthmus. (*Musée Dupuytren* 753.)

FIG. 218.—Dry specimen showing definite ridge (vertical in photograph) between acetabulum and retro-acetabular surfaces below and false acetabulum above. (*King's College Hospital Museum.*)

### THE MUSCLES.

The muscles are of interest and importance.

**The Adductors.**—These are always shorter than normal. Except in the youngest children they offer resistance to complete reduction, and in all cases they have to be stretched or ruptured before a stable position for the reduced hip can be obtained.

**The Rectus Femoris.**—The direct head of the rectus, in most cases, runs a straight course in front of the capsule, the whole muscle being shortened. But when the dislocation is more directly upwards, this tendon arches forwards over the capsule, and obviously assists in the stabilization of the head. It probably serves this purpose after 'anterior transposition', and when a marginal displacement follows reduction. A bursa may be present between the capsule and tendon. The reflected head in most cases is displaced from its normal attachment to the bone by the dome of the capsule, over which it arches backwards and to which it is attached. Occasionally it retains a portion of its bony origin, and still more rarely it may be found arising from the ilium high up above the false acetabulum, or even in front of this.

The hamstrings are short but of little importance, since they are easily relaxed by flexion of the knee during reduction, and can be stretched without difficulty later. The sciatic nerve is short, but can be relaxed like the hamstrings, and should not be in danger even when the shortening is considerable, if the knee and hip are kept flexed during reduction and the former is not extended too forcibly afterwards. Damage to this nerve has occurred during reduction as a result, I think, of bruising by a wedge or other fulcrum, rather than by stretching. I am convinced this was so in the solitary instance in which I produced a temporary paralysis of this nerve.

**The Ilio-psoas.**—This is important. Instead of the tendon, which is formed unusually high, passing downwards with a slight inclination backwards, it passes very decidedly backwards and outwards, in close contact with the capsule in the region of the isthmus. When the femur is much displaced, the pelvis tilted, and the lordosis marked, this tendon takes a practically horizontal course after leaving the pelvis. The strain put upon it is shown by the deep groove seen in every adult specimen below the anterior inferior spine. Jackson Clarke[24] says the tendon may be cartilaginous where it traverses this groove. The muscle and tendon unquestionably act as a sling to support the pelvis on the femur, while Carnochan[25] and Tubby[26] both suggest the pull of the psoas is responsible for the lordosis. Possibly this is correct, but the shifting backwards of the point of support must be regarded as of paramount importance in this respect. While Bradford and Lovett[27] describe the ilio-psoas as short, Lorenz[28] says it is long. We are inclined to agree with the former, and to regard the division of this tendon, as suggested by Burghard,[29] as an important item in the technique of open reduction.

**The Glutei.**—These are said to be unaltered in length, presumably because the trochanter is displaced outwards as well as up. In all cases with much displacement the gluteus medius, particularly the fibres which arise nearest the crest, must be shortened, but in the younger children there can be little change in these gluteal muscles, or we should never obtain reduction with such ease and certainly never retain it with the trochanter lying at a lower level than the head, which is the state of affairs invariably seen in radiograms with the limb in the Lorenz position. The gluteus minimus is in close apposition to the capsule, into which it is partly inserted, and from which it is separated with some difficulty. This muscle stabilizes the head by holding it against the ilium and by strengthening the dome of the capsule. It

is not a strong muscle, however, since its normal attachment has been usurped to a large extent by the dome of the capsule.

**The Horizontal Group of Muscles.**—These muscles, i.e., the obturators, gemelli, and quadratus, are lengthened and the direction of their fibres is altered. They no longer run horizontally, but pass upwards and backwards to reach the trochanter; they serve a useful purpose as slings for the pelvis (*Fig.* 219). Both the obturators would seem to be particularly useful in this way, the external because even in the normal hip its direction is slightly upwards, and the internal because of the pulley round which it turns as it leaves the pelvis. These muscles assist in keeping the femoral head home in the false acetabulum. After reduction no doubt they are slack, but, so long as the limb is in the right-angle position, their place is taken in this respect by the adductors and hamstrings. The desirability of restoring the short muscles to a taut and vigorous condition before the leg is allowed to return to the vertical position, is an argument in favour of encouraging

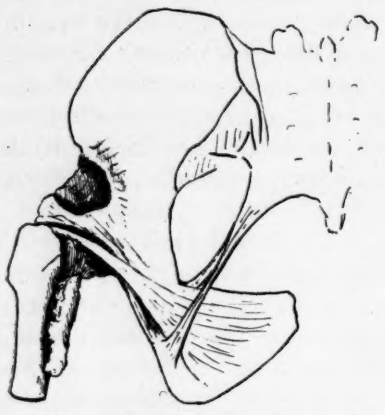

FIG. 219.—Same as *Fig.* 210, from behind, to show obturator internus muscle and large facet on lesser trochanter.

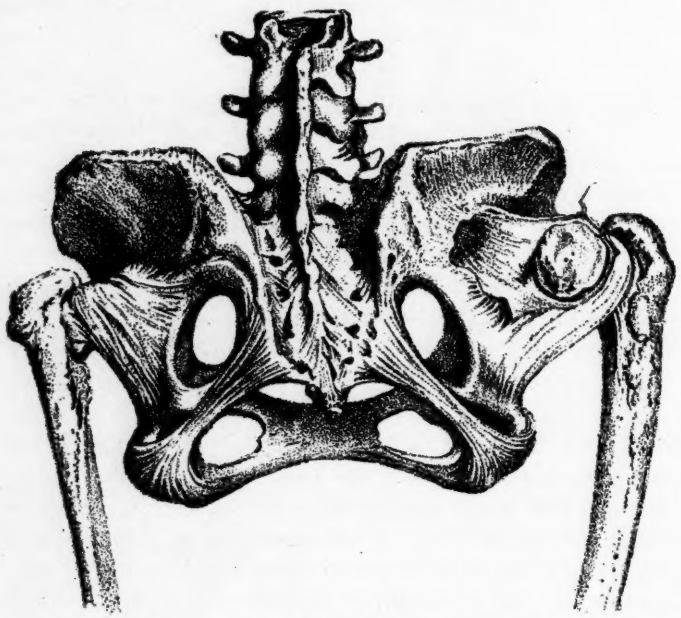

FIG. 220.—Posterior view of *Fig.* 216. Note capsular sling on each side.

walking during the period of plaster fixation, and of not including the knee in the cast.

Having considered the anatomy in some detail, it should now be possible

to form an opinion as to the method of suspension of the pelvis on the femur when the latter is dislocated. To begin with, it seems clear that, except in the ultra-arthritic case with gross lipping of the false joint, the bones have little or nothing to do with it. The work appears to be shared by the capsule and the muscles, as our knowledge of anatomy would lead us to expect. The capsular strain is taken by the thickened bands passing from pelvis to femur in front and below, but particularly by the *capsular sling* arching over the neck (*Fig.* 220). The muscles which assist the capsule and prevent further stretching of this sling are the ilio-psoas in front and the obturator group behind, while the gluteus minimus gives such help as it can.

## THE LIMP.

Why does a patient with a congenital hip walk in the characteristic manner? Why must the body weight be thrown towards the affected hip by a cast of the shoulders? Obviously because the abduction power at the hip-joint is diminished. But why is this diminished? Four possible explanations strike one at once: (1) The instability of the fulcrum; (2) Deficient power of the abductors; (3) Diminished leverage for these muscles; and (4) Shortening.

1. **The Instability of the Fulcrum.**—It must be remembered that the femur, though greatly displaced, is prevented from riding up indefinitely on the dorsum ilii. After a variable number of years, twelve or thirteen according to Simpson,[30] it ceases to migrate, and long before adult age is reached its progress is stayed by the capsule and muscles, so it is difficult to believe that this is the sole or main factor.

2. **Deficient Power of the Abductors.**—The abductor muscles, it should be remembered, have developed with the femur displaced, and have not been relaxed by any rapid migration of the femur as occurs in a pathological dislocation. The glutei, however, are diminished in strength because the area from which they can arise from the ilium is reduced by the presence of the displaced capsule. We have to admit, therefore, that these abductor muscles are weaker than normal, but that they may rapidly become equal to their task is proved by the perfect gait assumed a few months, even a few weeks, after removal of the plaster cast when a successful permanent reduction has been accomplished.

3. **Diminished Leverage for the Abductors.**—As to diminished leverage, there are three levers the lengths of which have to be considered. These levers are represented diagrammatically in *Fig.* 221, a plan slightly modified from that suggested by Girdlestone[31] for pathological dislocation.

But the abductor muscles can be considered from another point of view. We can take it, I think, that the result of the combined effort of the abductor muscles in supporting the pelvis on the normally articulated femur acts in the transverse vertical plane of the body. The fact that the head normally lies in a plane anterior to that of the trochanter is allowed for by the glutei being attached to the front rather than the back of this process. When, however, the anteversion of the neck is excessive, is it not possible that these muscles tend to produce a rotation of the femur, a twist of the trochanter

backwards, which has to be checked either by excessive action of the abductor muscle fibres lying to the front, or a diminished action of those behind the plane of movement ? The result might well be a functional weakness of these muscles. A further point is that the head, even if stable as regards further upward displacement, is unstable in the antero-posterior direction, as is suggested by the greater size of the false acetabulum in the horizontal plane than the size of the head demands. As the trochanter tends to rotate backwards during abduction, so the head would tend to slide forwards. If a

FIG. 221.—Unilateral case to show leverage. The distance (H T) from the centre of pressure on the head to the trochanter—in the transverse plane of the body—may be normal, but is diminished if the neck is short or the head flattened, and also when the antetorsion is excessive. The shorter this lever, the weaker the abductor power of the glutei. The second lever (H I), formed by the ilium and measured from the head to the top of the crest, is always diminished, and often very markedly so. Even though the first lever happens to be normal in length, the inevitable diminution of the second puts the abductors at a great disadvantage. Though only one of these levers comes into play at a time—according as the limb is moved on the pelvis or vice versa—the length of the other determines the direction of the abductor muscle fibres and therefore has great influence over their power. The third lever (H W), formed by the pelvis, is measured horizontally from the centre of pressure on the head to the mid-line, which is taken as passing through the centre of gravity of the body. Since the femur is always displaced outwards as well as upwards, this lever is always increased in length, and the load the abductors have to support is thereby increased. When the neck of the femur is of good length, and the upward displacement not extreme, this last factor is possibly the most important of the three. To sum up, in all cases the abductor muscles of a dislocated hip act under decided mechanical disadvantages.

bilateral case is carefully watched when walking, the upper ends of the femora can be seen to move regularly backwards and forwards. This instability of the head in all probability plays an important part in the production of the gait. It is well known that when the dislocated head lies further forward than usual, whether placed there by nature or by the surgeon, the gait is often surprisingly good. It seems possible that this may be due to the greater

antero-posterior stability as much as or even more than the better vertical stability of the head in such cases. I am not prepared to exclude any of these factors as playing a part in the production of the so-called limp, and each must be kept in mind when considering the treatment of a case in which reduction is impossible. There is yet another factor, however, which occurs to one as not unimportant. If we are correct in attributing to the obturators and their associate muscles the important functions of assisting to suspend the pelvis and to hold the femur pressed to it when weight is borne on the leg, these muscles must also at the same time tend to adduct the femur. If this is correct, the abductors not only have to support the weight of the pelvis, but also to check this adduction pull of the obturators, and this they are unable to do: hence, in part, the rolling gait and the positive Trendelenburg sign.

4. **Shortening.**—The shortening seen in a unilateral case may accentuate the limp, but does not account for it. Compensation for the shortening may diminish, but never corrects, the faulty gait.

## PATHOLOGICAL CHANGES.

Now many of the anatomical facts referred to are secondary and pathological rather than purely anatomical changes incidental to the displacement of the femur from the socket. The difficulty is to say when changes of form in the head of the femur and false acetabulum end and arthritic changes begin. There is no doubt but that flattening of the head occurs in children, particularly the older ones, without pain or other signs of arthritis, and I think we must regard such changes as due to altered anatomy rather than to arthritis. On the other hand, there is abundant evidence in the experience of every surgeon of the development of gross osteo-arthritis in the false joint. Many surgeons, however, including myself, have been impressed with the frequency of pain and other signs of arthritis in a congenitally unstable or subluxated joint previously regarded as normal, while the opposite hip, completely dislocated, gives no trouble.

Now the arthritis which occurs relatively late in life is essentially traumatic and the result of instability, but what of the cases that develop pain comparatively early? Is this pain merely a strain pain, or is it arthritic in origin, and if the latter, is this arthritis infective or simply the early stage of osteo-arthritis? If due to strain and to stretching of the capsule, insufficiently assisted by the muscles, we should surely expect to find that it is accompanied by further displacement of the femur, but, so far as I know, evidence of this is lacking. It is possible, and I think probable, that the pain in such cases is due to muscle tiredness rather than to stretching of the capsule. Walking is a great effort, especially when the deformity is bilateral. These patients often walk late, and cannot walk as far as normal children of the same age. When increase of weight occurs at puberty, perhaps accompanied by somewhat impaired health, it is not surprising that greater discomfort is experienced. Pain in the back experienced by older children may also be due to muscle strain, but occasionally it is sacro-iliac in origin. At the same time definite arthritis, more suggestive of infective than simple traumatic arthritis, does occur at a comparatively early age in a few cases. I

have met with villous arthritis at the age of 13 in an untreated case. The head of the femur in this patient displayed but slight erosion and no lipping, the synovial membrane alone showing any marked change. *Fig.* 222 shows the changes that had taken place in the head of one femur, the left, in the course of twelve months in a patient of 23, who could not walk without assistance. On opening the joint, blood-stained fluid escaped, though no manipulation had been done; the erosion of the cartilage was evident, the synovial membrane was gelatinous-looking and shaggy, but not villous, while the head had soft areas in it. This hip had been regarded as normal in childhood, when the other was unsuccessfully treated. This patient was delicate-looking, but without any discoverable septic focus.*

FIG. 222.—Bilateral dislocation in a woman of 23. The right hip had been treated in childhood; the left was undiagnosed. Note irregularity of outline of left femoral head, not present a year previously.

I feel sure that the general health of the patient, particularly as regards septic foci, is a very important factor—possibly the determining factor—in the incidence of arthritic trouble at a relatively early age. Experience of arthritis after reduction gives some support to this view, though trauma as a factor necessarily comes into the picture. If sepsis is not the decisive factor, how can we account for those cases, by no means rare, in which a woman with one or both hips dislocated will reach the age of 35, 40, or even more without any appreciable discomfort? To cite two examples: a woman of 35 in poor circumstances with bilateral dislocation married and had five children, one with a hip dislocated, but never experienced a day's pain; another woman, in better circumstances perhaps, had a dislocated left hip, was the mother of eight children, and had no pain till she reached her 45th year. Unfortunately there seem to be no statistics available as to the frequency of gross disability in cases past their childhood. At present I am not convinced that the pessimistic views held by many, probably by most, surgeons

* Since this lecture was delivered, this patient has developed infective arthritis of one wrist.

as to the future of the untreated case are correct. I admit the serious disability experienced by many, but I do feel that we should not forget that there are quite a number of cases who live well into middle age with little or no discomfort. Unsuccessful attempts at reduction or transposition must, I think, be regarded as increasing the probability of arthritic changes developing. This must be kept in mind when a case is not seen until after the usual age limit for reduction is passed. Pseudo-coxalgia in the untreated case has not been met with either personally or in the literature, though it is relatively common after reduction. I have no experience of the incidence of specific infections such as tubercle, and the literature gives little help. Caesarono[32] quotes two cases of tubercle supervening in a dislocated hip, but in only one of these was the nature of the infection definitely proved.

## TREATMENT.

Now let us turn to the treatment and see whether any of the above facts and theories can help us. The objects of treatment are two: (1) To provide a stable joint and obliterate the limp; and (2) To diminish the chances of

FIG. 223.—Radiogram of congenital dislocation of left hip, twenty years after reduction at age of $2\frac{3}{4}$ years.

arthritis supervening. Both these objects are undoubtedly best served by manipulative reduction *at an early age*. If the hip is reduced before the age of 3, and better still before the age of 2, and a permanent cure results, in a very large percentage of cases the hip will be approximately normal and stand the wear and tear of life almost—though probably not quite—as well as a hip that has never been abnormal. *Fig.* 223 shows the condition after twenty years in a case reduced at nearly 3 years of age. It is now almost

twenty-six years since the operation was performed and the patient has a hip that is perfect in every way. *Fig.* 224 shows a hip reduced twenty-two and a half years ago, at the age of $3\frac{1}{2}$. There is a slight increase in size of the femoral head on the dislocated (right) side, but otherwise it would pass as a normal joint. The patient is now a domestic servant, leading a very hard life, with a lot of running up and down stairs, and she says she is tired out by the evening, and then feels the hip that was dislocated. Other similar cases with perfect anatomical results have told me that if they get tired out the reduced hip always troubles them first.

FIG. 224.—Radiogram of congenital dislocation of left hip twenty-two and a half years after reduction at the age of $3\frac{1}{2}$ years.

The older the patient at the time of reduction, the greater the chance of an imperfect anatomical result. In such cases we have achieved our first object, but in all probability have failed in our second. Putti[33] says a congenital hip should be treated as early as possible—that is, as soon as the diagnosis is made—but I am not convinced that there is any advantage in reducing the hip before the age of 18 months, and there are many obvious disadvantages. In most cases the head enters the acetabulum over its posterior margin, after having been brought down to rest on the ischium, over which, as we have shown, the joint cavity extends. If it can be lifted in, as it often can be in the youngest children, before the limb is abducted, so much the better. The synovial fold which, if present, descends in front of the head in the more difficult cases suggests we should take advantage of Ridlon's[34] method of thrusting downwards the fully flexed thigh—the knee being towards the opposite axilla—rather than rely on the abduction leverage method alone. It seems rational, considering the way in which the anterior part of the capsule is stretched across the acetabulum like a lid, that after the head has been apparently reduced, further abduction movements combined with rotation inwards and outwards should be carried out, in order to stretch up this lid and get the head well home. To be convinced of the advantage

of these manœuvres one has only to test the stability of the reduction before and after they have been performed. This seems to me an important part of the operation.

Now there is a growing tendency in the United States, and signs are not entirely wanting of the same tendency in this country, to favour open reduction not only when manipulative reduction has failed, but almost as a routine, even in the youngest children. The decision for or against open operation depends very largely on the view held by the individual surgeon as to the degree of development of the capsular isthmus in young children, and the obstruction this offers to reduction. In 1903 Sir Robert Jones,[35] in the course of the discussion on Burghard's[36] second paper advocating open operation, is reported as having expressed the following opinion: "The causes of failure were . . . sometimes constriction of the capsule, the importance of which was over-rated". I understand Sir Robert still holds the same views, and I venture to endorse them emphatically. The results of manipulative reduction prove conclusively that in the youngest children at any rate, the reduction is complete in the vast majority. Is it right to inflict the extra risk of an open operation on all because very occasionally—and we must admit this—capsular constriction, an abnormal ligamentum teres, or some less obvious factor prevents a stable reduction being obtained by manipulation? Simple open reduction, which we owe to Burghard, whose operation comprised the important details of dividing the psoas and enlarging the isthmus, is unquestionably a useful procedure in selected cases, rarely met with before the age of 4, though more commonly afterwards. Even with the help of open reduction I do not think the age limit of 6 for a bilateral and 9 for a unilateral case should be exceeded. Galloway[37] has been the strongest advocate of a more extended use of this method in recent years, but I am not sure that his published results give much support to his views. For instance, he reported a further series of 38 hips in 1926. Of these, the cures were 15 (less than 50 per cent, be it noted), the good results 18, the doubtful 5, and failures none. It is not clear what exactly constitutes a good result which is not a cure and yet not a failure. It must be insisted upon that open reduction *per se* has no advantage whatsoever over the closed method, reduction being complete in both cases. After both the acetabular margin must grow out, and for this prolonged fixation is necessary.

The next question involves the importance of antetorsion, the influence of this on the results, and the advisability of correcting this deformity by osteotomy. Opinions differ widely. Lorenz,[38] Bradford,[39] and Gill[40] all regard it as unimportant, the first going so far as to say that its correction may lead to posterior subluxation. On the other hand, most writers are not prepared to disregard it, though they differ as to how, when, and where it should be corrected. Osteotomy is the usual method adopted, but Galleazzi[41] claims to correct it by plaster in inversion and active and passive exercises. Soutter and Lovett[42] say antetorsion improves with weight-bearing, especially after two or three years. Hibbs,[43] Calot,[44] and others do osteotomy in the lower third of the bone, while Froelich[45] snaps the atrophied femur over the edge of the plaster some months after reduction. Others divide the bone in the upper third. Schede[46] and Codivilla[47] use a nail driven into the trochanteric

region, to control the upper fragment. As to the degree of antetorsion demanding correction, Durham[48] operates on anything over 45°, while Werndorf[49] puts the limit at 60°, and Bradford and Lovett[50] say 90° antetorsion is incompatible with normal gait and must be corrected. Our experience is that if hips are reduced early, say before the fourth year, it is excessively rare to meet with a case which demands osteotomy. In the older cases, which should become less and less numerous, a degree of antetorsion of real importance, i.e., over 45°, is more common, but still rare. Failure of the upper lip of the acetabulum to grow out seems to me a far more potent factor leading to re-dislocation than any deformity in the femur.

The next problem is: Should anything be done, and if so what, to the adolescent or young adult with this deformity who suffers little or no discomfort, and never complains of real pain? In a previous paper[60] I produced evidence to show how far from perfect were the anatomical results after reduction in the older cases, even though the head of the femur, or what was left of it, remained in the acetabulum. Gross erosion from 'absorptive arthritis' was present in most. Further experience has not led me to alter the opinion then expressed—namely, that it was more than doubtful whether much good had been done; in fact, it was probable that actual harm had resulted, and that the grossly abnormal joint was even more likely to give rise to pain, and this at an early age.

Hey Groves[51] has suggested leaving the capsule intact around the head, separating it from the bone, and shifting it down to the acetabulum enlarged sufficiently to receive it. So far no detailed results in a series of cases treated in this way have been published. Though this ingenious method might be useful in an occasional selected case over the age limit given above, I can see no advantage in it over open reduction, coupled with a bone-grafting operation to make an upper lip, when the femur can be brought down to the requisite level. Unless this last can be achieved with reasonable ease it is better to leave the femur where it is. This brings us to the question of the bone-graft or bone-flap operation, first performed, according to Epstein,[52] by Koenig in 1891. The formation of an artificial lip to the acetabulum is a most useful operation, and is being performed with ever-increasing frequency by surgeons throughout the world. It is sound from the anatomical point of view. The making of an efficient shelf is comparatively easy; the difficulty lies in making the shelf at precisely the right level. When relapse is seen to be occurring after manipulative reduction followed by prolonged fixation, or when simple reduction offers but little hope of a cure—for example, in a subluxated hip at 4 to 6 years of age, this operation is invaluable (*Figs.* 225, 226). The procedure should always be added to open reduction when the condition of the patient permits.[60] Anterior transposition, or the shifting forwards of the head towards the anterior inferior spine, by forcible manipulation under an anæsthetic, is practised by many surgeons in irreducible cases. By moving forward the point of support and increasing the range of extension and abduction the gait may be greatly improved. We have found this a difficult thing to achieve, and moreover relapse may occur. Lance suggests it is best suited to young adolescents just too old for reduction. Galeazzi[53] and Loeffler[54] both prefer open transposition. Adduction and flexion deformity

are, however, more satisfactorily corrected by osteotomy, at any rate in a unilateral case. The chance of arthritis in the future is not materially lessened by either of these operations, while in the former it may well be increased.

FIG. 225.—Unilateral congenital dislocation before operation. Age 5½ years.

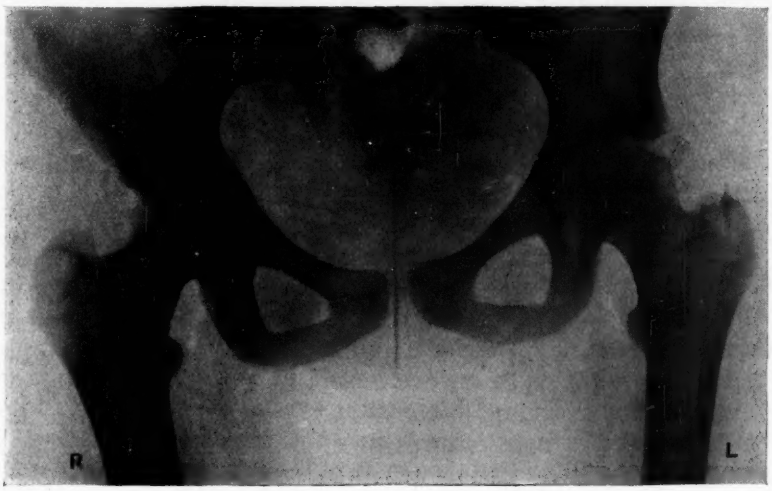


FIG. 226.—Case shown in *Fig.* 225, seven years after open operation for making an upper lip to the acetabulum.

Finally, we have to consider the difficult problem of the irreducible case which develops an increasing amount of disability and pain in adolescent or adult life. The difficulties are much increased when the deformity is bilateral, even though the symptoms be practically confined to one hip. It has already

been suggested that pain and greater disability may arise from muscle strain, but in all severe cases it probably results from arthritis. At the very least such cases must be regarded as potentially arthritic, and this must be taken into consideration in deciding what treatment to adopt. We have the following procedures to choose from: (1) Arthrodesis; (2) Osteotomy; (3) Shelf operation; (4) Excision of the head of the femur.

1. **Arthrodesis.**—This is unquestionably the operation which offers, if successful, not only the best but the sole hope of permanent relief, and in unilateral cases it would seem to deserve first place. An exception might be made in the case of an adolescent with a moderate amount of pain and little or no radiographic evidence of arthritis. In such a case osteotomy of some kind might be preferable. It would seem to be wisest, when arthrodesis is decided upon, and the displacement is more than a mere subluxation, not to try to bring the head down to the acetabulum, but to gouge out a socket between the true and false acetabula. A moderate amount of difficulty in getting the head into the hole thus made for it is highly desirable, to ensure close contact of the bony surfaces. In a recent case operated upon bone-grafts were utilized over the head, both to increase the chance of ankylosis and to provide a good shelf supposing the bones failed to unite. In a bilateral case arthrodesis of the hip giving the greater amount of pain may be the only possible procedure. Anything short of this would run the risk of throwing more strain on the painless or less painful side, with the inevitable result of increased arthritis and pain. The necessity of preventing adduction of the unoperated side calls for fixation of the arthrodesed hip in but slight, if any, abduction. In a middle-aged patient we may even be forced into attempting the fusion in an adducted position.

2. **Osteotomy.**—In 1925 Lance[55] published a most valuable paper on this subject, and in it he discusses the relative value of the various osteotomies that have been tried for these cases. The possible methods are shown in the series of diagrams taken from his paper (*Fig.* 227). His decision is against the bifurcation operation of Lorenz[56] and in favour of the simpler operation of Froelich, since if the former is successful and the end of the shaft really enters the acetabulum all movement is practically obliterated. It seems probable that after the lapse of a year or two all osteotomies performed at or just below the trochanteric region would look very much alike in a radiogram. After osteotomy, contact of the femur with the pelvis in all probability takes place over the retro-acetabular surface rather than opposite the socket itself. It is difficult to believe, however, that any of these osteotomies can do much to relieve the arthritis or the symptoms thereof. What is the anatomical result of a bifurcation or other type of osteotomy? If successful, the bent-in portion of the femur will take purchase against the pelvis, the weight being borne with the leg in the abducted position; but it is doubtful whether the femur really hitches in the acetabulum sufficiently to take much of the weight, or that it does this for more than a few months. If the operation is successful in the obtaining of a new point of support, it inevitably follows that movement must be limited, and this limitation in many cases seems to be considerable. Where does this movement take place? Either the femur hinges at the head, and the new 'articulation', if we may call it so,

allows forward and backward gliding movements, or the new articulation acts as the hinge and the head glides backwards and forwards, or gliding movements may take place at both. In any case some movement must take place at the head, and if arthritis is present, as we contend it is in most cases, is relief of pain to be expected? If movement is reduced to a minimum, I can understand considerable relief of pain being the result, but in that case is this operation any better than an arthrodesis except in so far as it is a much simpler procedure? There is, however, another possibility. When union has occurred after osteotomy and walking is commenced, the amount of abduction must tend to diminish, and if this takes place, the head of the bone will be levered outwards away from the ilium, the pressure between the

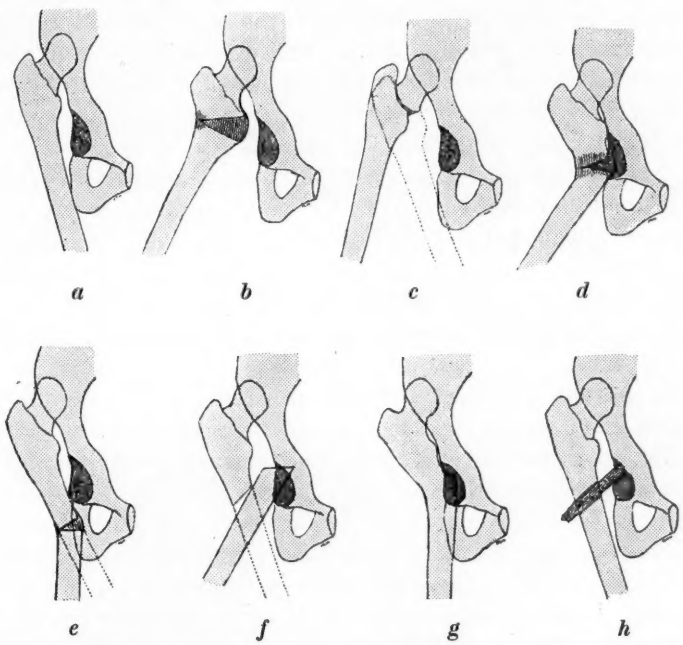


FIG. 227.—Diagram showing various osteotomies. *a*, Posterior dislocation; *b*, Kirmisson's subtrochanteric osteotomy; *c*, Curvilinear transtrochanteric osteotomy; *d*, Froelich's para-acetabular osteotomy; *e*, Schanz's ischiatic osteotomy; *f*, Lorenz's bifurcation operation; *g*, Remote result of Lorenz's operation; *h*, Maragliano's operation. (*After Lance.*)

two bones will be relieved, and thus the pain may be diminished or cured. As Girdlestone[57] points out in writing of pathological dislocation, the lower the osteotomy the greater the mechanical leverage that results.

Some of my friends are pleased with their results of the bifurcation operation in unilateral cases. Galeazzi, on the other hand, condemns osteotomy as mechanically unsound, and says the results are limited and transitory. There is so much difference of opinion on the value of osteotomy that I regret the more that my personal experience is insufficient to warrant a decision as to the value of this operation. So far as I can remember, only one case has been exhibited in London after a bifurcation operation, and this, a bilateral case, was not, I think, shown as a success. It would seem to me that

osteotomy is most likely to be successful, for a period of a few years at any rate, in cases a little over the age limit for reduction, whether performed to correct exceptional deformity or in the hope of relieving pain.

3. **The Shelf Operation.**—The so-called shelf operation for irreducible cases has been advocated strongly in recent years by Dickson, and to some extent by others. Dickson[58] cuts the capsule freely away, applies mechanical traction, and endeavours to bring the head some way downwards as well as forwards, before turning down a shelf of bone above it. If the head is already much damaged by arthritis, and this is certain to be the case where the patient is an adult and suffering much pain, can we expect the new joint to remain painless for long? However, Dickson is satisfied with his results, and gives details of one or two cases which were certainly greatly benefited by the operation. So far as I know, he has made no further report since his original paper in 1924. Mechanically this operation should increase the stability and improve the gait to a slight extent. The stability might, I think, be improved by carrying the shelf in front of and particularly behind the head, and by shifting the trochanter forwards on the femur. Although I have always doubted the soundness of this operation on theoretical grounds and have never performed it, I think there is one point definitely in its favour: even if it fails to give relief, or does so only for a time, it has prepared the way for a satisfactory arthrodesis. In a bilateral case, when one side has been arthrodesed, it may be the only operation open to the surgeon. Allison,[59] in a recent article, advocates the shelf operation as the best procedure in adult cases.

4. **Excision of the Head of the Femur.**—This operation unquestionably relieves the pain at once, and for so long as a weight-relieving caliper is worn afterwards. When, however, the splint is discarded pain soon returns, while the limp is necessarily even worse than before.

To sum up: we feel that arthrodesis is unquestionably the best method and the only one likely to relieve the pain permanently, but that osteotomy is useful in a few selected cases. The shelf operation, in the absence of any recent publication of the results in a series of cases, would seem to be still on probation.

## SUMMARY.

In this paper I have endeavoured to call attention to the chief points of interest and importance in the anatomy of congenital dislocation of the hip. In particular the changes in the bone behind the acetabulum, with the occasional formation of a facet at this spot, the arrangement of the capsule and the importance of the ischio-capsular band which forms a sling over the neck of the femur, have been pointed out. The muscles which chiefly assist the capsule in slinging the pelvis on the femur are, I contend, the psoas in front and the obturators and their associates behind. Factors which may contribute towards the production of the characteristic gait, and the causation of the pain experienced in later life, are discussed. Finally, in a rapid survey of the treatment, the various operative procedures at our disposal have been criticized in the light of the foregoing facts and theories.

In these days of Child Welfare Centres, better diagnosis, and the ever-increasing practice of routine X-ray examinations, the number of cases of congenital dislocation left untreated till all hope of a cure is past is gradually diminishing. It cannot be insisted upon too strongly or too often that these cases must be sent to the surgeon early. Treated in early childhood the majority are cured by the manipulative method, and of the rest an ever-increasing number should be cured by open operation.

Is it too much to hope that the time will come, and that before many years, when every uncomplicated congenital hip will be cured at an early age, and the difficult problems presented by the irreducible case, hopelessly crippled on reaching adult life, will cease to trouble the surgeon?

The author wishes to record his great indebtedness to the Curator of the Musée Dupuytren in Paris for permission to make free use of the numerous invaluable specimens of congenital dislocation of the hip in that museum.

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# SPONTANEOUS RUPTURE OF THE NORMAL SPLEEN.

By HAMILTON BAILEY,

SURGEON TO THE DUDLEY ROAD HOSPITAL, BIRMINGHAM.

So contrary is it to the established conceptions of pathology, that there are many who doubt that a normal spleen can rupture spontaneously. There is every excuse for such an attitude; at the most there are but eleven recorded cases (*Table I*) of the condition, and the first of these was published in 1919.

*Table I.*—Analysis of Cases of Spontaneous Rupture of the Normal Spleen.

| Author | Sex and Age | The Nature of the Rupture | Result | Microscopical Examination |
|---|---|---|---|---|
| 1. Shorten .. .. | M. 43 | Tear in splenic pulp | Recovered | Normal spleen |
| 2. Connors .. .. | M. 38 | Subcapsular hæmatoma | Recovered* | Not done |
| 3. Metcalfe and Fletcher | M. 21 | ? | Recovered | Normal spleen |
| 4. Metcalfe and Fletcher | M. 21 | Rent in convex surface | Recovered | Normal spleen |
| 5. Skerritt .. .. | M. 53 | Subcapsular hæmatoma | Died | Not done |
| 6. Atkinson .. .. | F. 35 | Lower pole pulped | Died | Not done |
| 7. Susman .. .. | M. 53 | Subcapsular hæmatoma | Died | Normal spleen |
| 8. Rhame[1] .. .. | M. 23 | Rent in convex surface | Recovered | Normal spleen |
| 9. Remynse[2] .. .. | M. 16 | ? | Recovered | Not done |
| 10. Capecchi†[3] .. .. | F. 27 | Large rent in splenic pulp | Recovered | Apparently normal |
| 11. Girling Ball, reported by Underwood[4] | M. 50 | Tear on anterior surface | Died | Normal spleen |

* Died four years later from pulmonary tuberculosis. † Patient was four months pregnant.

In two of these eleven cases (Skerritt's and Atkinson's) the clinical notes are very briefly reported, and M. P. Susman,[5] from whose exhaustive study the above table is for the most part compiled, regards them as doubtful cases. This leaves us in possession of but nine authentic examples up to the present time.

The report of an additional case will help to consolidate the position of spontaneous rupture of the normal spleen as an established clinical entity.

## CASE REPORT.

History.—On March 31, 1929, L. P., a male van driver, age 20, was seized with severe abdominal pain whilst sitting in a chair at home. Up to that time he had been perfectly healthy, except for a right-sided empyema in infancy. All his life had been passed in Birmingham. He is absolutely certain that he had not been involved in any accident or received any blow at work or play during the past year.

On Admission.—The patient was admitted to hospital eighteen hours after the commencement of the attack. He stated that the pain commenced in the umbilical

region and radiated to the right hypochondrium. Later the pain became more severe and radiated to the left shoulder, and for about ten hours persisted in the left shoulder as well as the whole of the abdomen.

ON EXAMINATION.—The temperature was 101° and the pulse 100. The abdomen moved normally with respiration. There was some general tenderness, maximal in the right hypochondrium, where rigidity was also located. On the left side there was a mal-descended testis within a hernial sac. This was tender, and the sac contained fluid opaque to transillumination. I went to some pains to exclude the possibility of torsion of the testis with hæmatocele. A definite diagnosis could not be made, and the patient went to the operating theatre as a case of ? perforated duodenal ulcer, ? appendicitis.

OPERATION.—Anæsthesia was induced by injecting 0·7 c.c. of stovaine intrathecally. A small gridiron incision was made. On opening the peritoneum pure blood escaped profusely, and it was then that the probability of spontaneous rupture of the spleen crossed my mind. The gridiron incision was closed. At this stage the

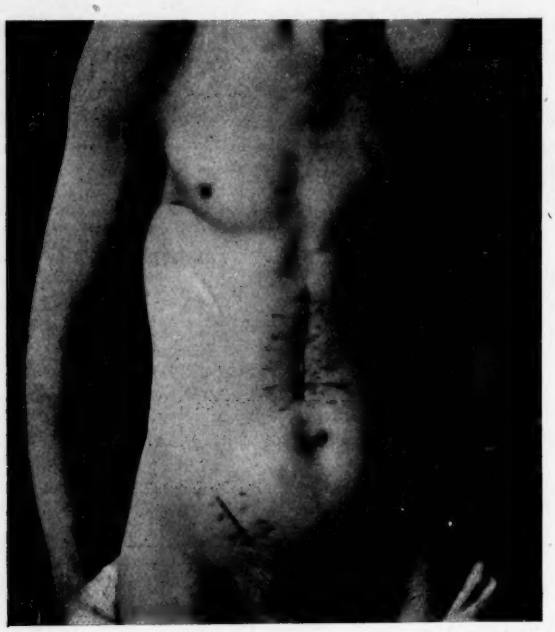
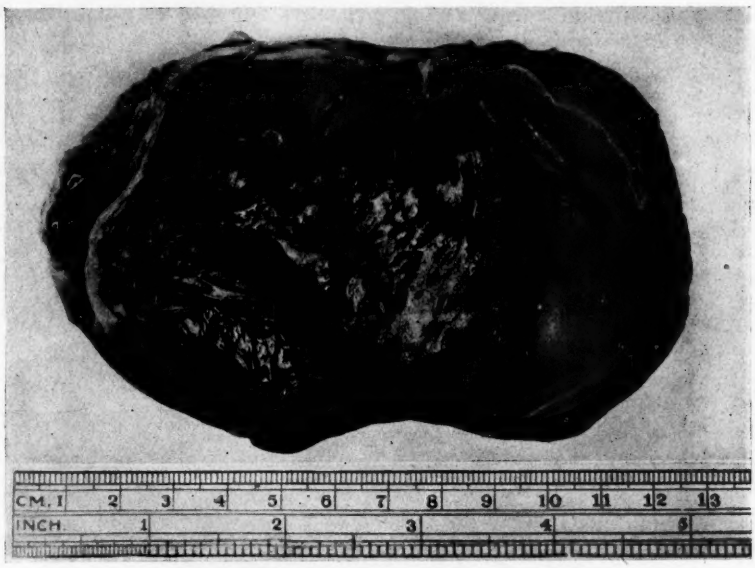


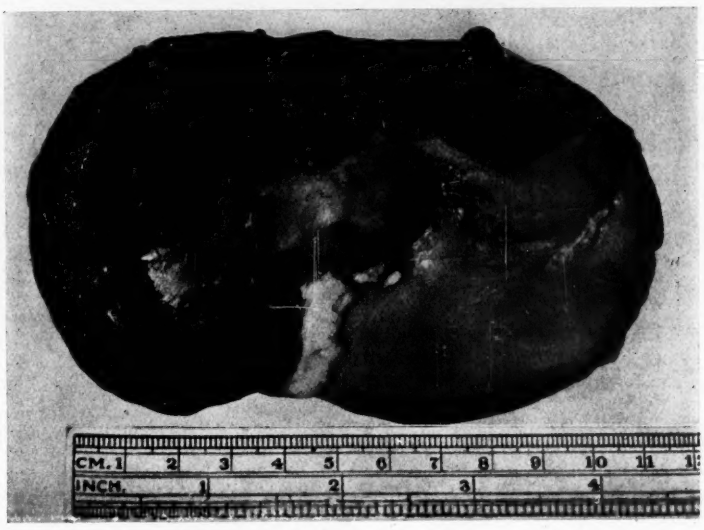
FIG. 228.—The patient six weeks after operation, showing the mid-line incision used for splenectomy.

anæsthetic was supplemented by a little gas and oxygen. A mid-line incision was made in the epigastrium, and on opening the peritoneum blood again poured out. The hand was passed into the left hypochondrium ; clots of blood floated up into the wound : the spleen felt large, and left little doubt that the source of the hæmorrhage had been found. Splenectomy was performed. Handfuls of clots were removed from the left upper abdomen, but no attempt was made to engage upon the Sisyphean task of mopping up the fluid blood. The abdomen was closed, the operation being completed in under half an hour. Subcutaneous saline was administered at the close of the operation and continued after the patient had been returned to bed. There were no post-operative complications, and the patient is in normal health at the present time (*Fig.* 228).

The excised spleen is shown in *Figs.* 229, 230. The photographs clearly demonstrate a subcapsular hæmatoma which has burst. The histological examination (*Fig.* 231) of the organ was undertaken by Dr. Whitelaw, and he

reports that the structure is that of a normal spleen. Serial blood-counts were carried out by Miss Trought, B.Sc., and the findings conform with those of traumatic rupture of the spleen.




FIGS. 229, 230.—Spontaneous rupture of the normal spleen. The subcapsular hæmatoma which burst is well shown.

## ETIOLOGY.

There are on record at least three examples[6, 7, 8] where, after successful splenectomy for supposedly *spontaneous* rupture, the investigator has been able to elicit the history of a blow. On the other hand, no such history was obtainable in my case, or in any of the cases included in the foregoing table.

An accident of sufficient magnitude[9] to rupture a normal spleen is unlikely to be forgotten by the recipient. To assume that all the patients whose spleen is alleged to have ruptured spontaneously had forgotten such an accident, or alternatively, had deliberately withheld information concerning it, seems impossible. Yet how else are we to account for the bursting asunder of a normal spleen? If the theory of an overlooked accident is discarded, we are plunged into a morass of speculation in which (on account of the great rarity of the condition) it is unprofitable to linger.

Only the spleen can behave in this curious manner, and from the practical standpoint there follows a good aphorism: "*In atraumatic hæmoperitoneum in the male examine first the spleen.*"

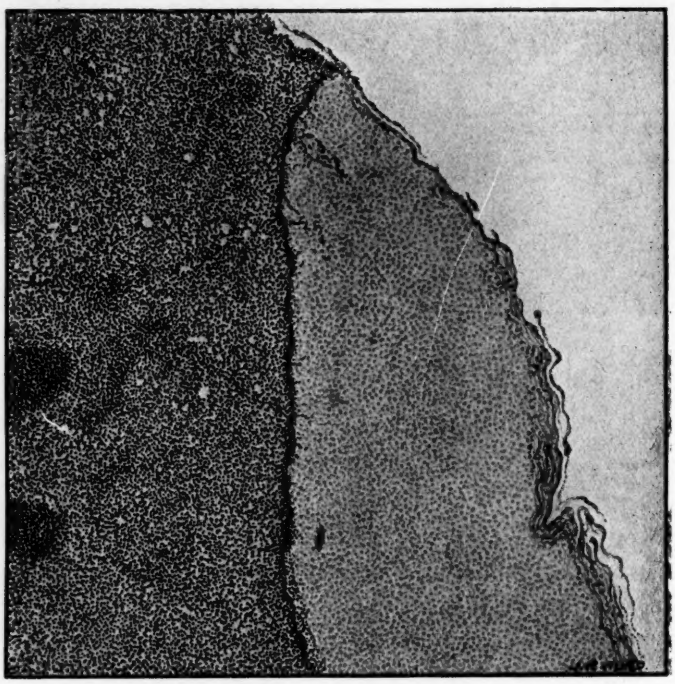


FIG. 231.—Section of the spleen, showing the subcapsular hæmatoma. (× 25.)

## SPONTANEOUS RUPTURE OF THE SPLENIC VEIN.

On the clinical side spontaneous rupture of the splenic vein bears comparison with spontaneous rupture of the spleen; pathologically the conditions are widely separated. The bursting of an engorged vein can be readily understood. In the only two examples which are available in the recent literature the liver was diseased, and as a consequence the venous pressure in the radicles of the portal vein would be increased.

Ogilvie's[10] patient was a clerk, age 31, who gave a history extending over eight years of attacks of jaundice. He was admitted into Guy's Hospital with an enlarged liver and spleen, and whilst in hospital suddenly presented grave acute abdominal symptoms. Laparotomy revealed a hæmoperitoneum,

and renewed hæmorrhage was controlled only after the splenic pedicle had been clamped. Splenectomy and autotransfusion failed to save the patient's life. Necropsy showed a malignant hepatoma with secondary deposits in the lung.

Pyrah, Stansfield, and Garland[11] have furnished another example. The patient was a woman of 38 who died six hours after the onset of acute abdominal pain. At necropsy the peritoneum was found full of blood, the source of the hæmorrhage being a tiny hole in the dilated splenic vein. There was well-marked multilobular cirrhosis.

## CONCLUSIONS.

1. A case of spontaneous rupture of the normal spleen is recorded.
2. Kehr's sign of left shoulder pain in ruptured spleen was well marked, although its diagnostic significance was not appreciated.
3. Yet another example of hæmoperitoneum with a comparatively slow pulse-rate is brought to notice
4. Additional evidence is afforded that the mid-line upper abdominal incision is adequate for splenectomy in cases of rupture.

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# A PLASTIC OPERATION FOR FACIAL PARALYSIS.

By W. O. LODGE,

HON. OPHTHALMIC AND AURAL SURGEON TO THE ROYAL HALIFAX INFIRMARY.

So far as one can judge from a solitary case, the procedure described below is worthy of more extended trial. It is designed to ameliorate disfigurement and to ward off impending corneal ulceration in long-standing cases of lower-neuron facial paralysis, more especially those due to mastoid disease, or accidentally inflicted during mastoid operations. Suitable cases are rare.

Without leaving conspicuous scars, three new ligaments are grafted into the face, corresponding in position to the inferior portion of the orbicularis oculi, the levator palpebræ superioris alæque nasi, and the zygomaticus major.

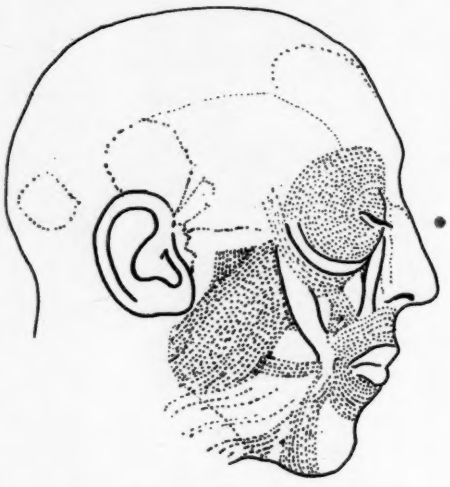


FIG. 232.—The muscles of expression. (*After Cunningham.*)

FIG. 233.—Showing the strip of fascia lata *in situ*.

(*Figs.* 232, 233.) These sustain the drooping lower eyelid and palsied side of the mouth, and make them conform to a more pleasing facial expression. The material employed is a continuous strip of fascia lata. General anæsthesia is induced, and a 2 per cent solution of mercurochrome is applied freely and widely to disinfect the skin, conjunctiva, and buccal surface of the cheek. A probe is passed along the inferior lachrymal canaliculus, to define its position. The angular vein and parotid duct must also be avoided.

Two short incisions are made, exposing the temporal fascia and the internal palpebral ligament respectively. The latter structure—a familiar

landmark in the operation of excision of the lachrymal sac—is invariably well defined. A third tiny incision is made at the junction of skin and mucous membrane at the angle of the mouth. Meanwhile an assistant has been excising as long a strip of fascia lata as can possibly be obtained, 5 mm. in width, from the outer aspect of the thigh ; this is threaded along a triangular course between the three facial incisions, among the atrophied muscles, with the aid of a packing needle. The internal palpebral ligament and orbicularis oris are encircled en route. The two free ends are drawn taut, and woven into the fibres of the temporal fascia. The incisions are closed and the tension is temporarily relieved with adhesive strapping.

The result is not so good as is obtainable in cases of shorter duration by facio-hypoglossal anastomosis, but the method has one real advantage—its effect is immediate.

# TOXIC GOITRE.

By T. P. DUNHILL, C.M.G.,

SURGICAL PROFESSORIAL UNIT AT ST. BARTHOLOMEW'S HOSPITAL, LONDON.

## ETIOLOGY.

A REASONED plan for the place that surgical procedure should occupy in the treatment of toxic goitre can only be made when the evolution of the disease is understood. There is not universal agreement on this point, but I believe that, apart from the inflammations and malignancy, thyroid diseases are linked together. The work embodied in this paper has been carried out in a clinical unit, and no claim is made to interpret difficult pathology. The difficulties of the interpretation of clinical conditions by examination of the pathological material are very great. Able pathologists are spending their whole lives at this problem; Marine, Scott Williamson, Pearse, and many European investigators have done invaluable work. The difficulties of the problem are shown by the statement by Marine,[1] who has spent more than twenty years at work on thyroid pathology, that he has found it vain to use human thyroids (whether obtained at surgical operation or autopsy) as his starting-point; while Scott Williamson and Pearse,[2] after stating some of the difficulties, write: "We would deprecate any attempt to solve these by reference to the clinical condition of the patient; that is indeed the source of all confusion in pathological studies." These statements should scarcely be quoted apart from their context, but we have inquiring minds, and we have to treat people who are ill, and we have to teach students who have inquiring minds. I therefore cannot agree that the clinical condition of the patient should be ignored, and only the histopathological appearances used in the grouping of goitres.

**Difference in the Types of the Disease.**—The differences which may occur in the manifestations of toxic goitre in different patients have been noted by all observers, and much ingenuity has been shown in accounting for them. These are so obvious as to suggest two diseases, one being called 'exophthalmic goitre' (*Fig.* 234), the other 'toxic adenoma' (*Fig.* 235). Not only are the manifestations in characteristic instances of the two types strikingly different, but the two types tend to occur at different periods of life; the so-called exophthalmic goitre, with its staring eyes, pronounced nervous symptoms, rapid but usually regular heart rhythm, being most common in early adult life. On the other hand, the so-called toxic adenoma is rarely associated with exophthalmos, the nervous symptoms are comparatively mild, but the heart rhythm becomes irregular, congestive heart failure is not uncommon, and this syndrome tends to occur about the period of life usually associated with the menopause—on an average two decades later than the onset of primary exophthalmic goitre.

There are, however, facts—I use the word 'facts' advisedly—which have always troubled some of us. We have tried to force cases into a type, and it has left us with an uneasy feeling from time to time that a case would not

FIG. 234.—Primary toxic goitre ('exophthalmic goitre').

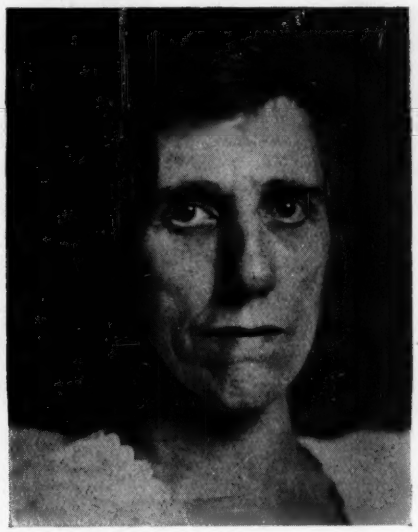


FIG. 235.—Toxic goitre ('toxic adenoma'): no exophthalmos, auricular fibrillation of nineteen months' duration.

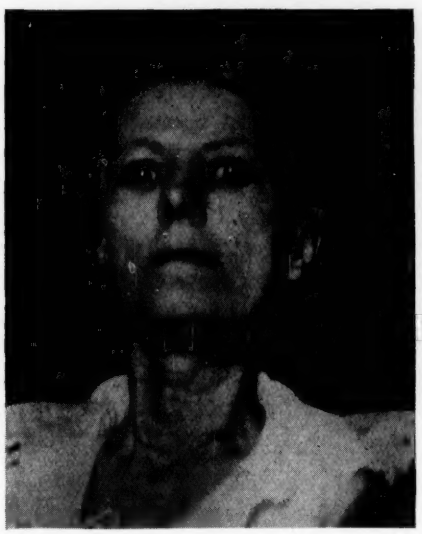


FIG. 236.—Primary toxic goitre with no eye signs.

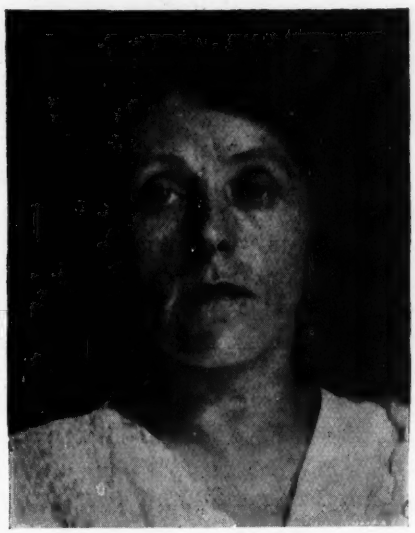


FIG. 237.—Bilaterally symmetrical goitre ('toxic adenoma'): no eye signs, auricular fibrillation.

fit in, notwithstanding that many did so readily. As examples, there are patients of the so-called exophthalmic type without exophthalmos (*Fig.* 236), and of the so-called toxic adenoma type with no obvious adenoma, but with

a diffuse goitre (*Fig.* 237).

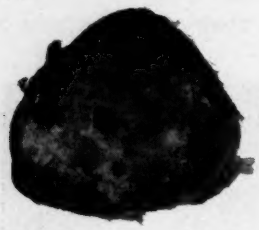


FIG. 238.—'Toxic adenoma': one single nodule, the remainder of the gland apparently normal.

The eye signs vary in degree. There may be extreme proptosis, or the slight but unmistakable lift of the eyelids without proptosis, or there may be no eye sign present. Again, in the so-called toxic adenoma group, in a typical example there is present a single adenoma (*Fig.* 238); but another with similar symptoms will have an irregular adenomatous mass (*Fig.* 239), a nodular goitre more or less bilateral, or a bilaterally symmetrical goitre in which the irregularities of surface are so slight that it feels almost smooth (*Fig* 240).

FIG. 239.—'Toxic adenoma': auricular fibrillation; an irregularly shaped unilateral mass.

FIG. 240.—'Toxic adenoma': auricular fibrillation, no exophthalmos; bilateral enlargement, almost smooth.

**One Single Disease.**—Lengthening experience, with observation of patients suffering from toxic goitre, followed by operations upon them, examination of pathological material removed, together with the later histories, have compelled me to believe that these patients do not belong to two distinct groups; and that the difference, striking though it may be in extreme cases, is of degree only and not of kind. My belief now is that a full range of cases exists representing every stage between exophthalmic goitre at one end and toxic adenoma at the other, and that we can observe in a graded series of patients exophthalmos and central nervous system symptoms becoming less and less until they almost or entirely disappear. Corresponding with this we can observe the thyroid gland become less smooth and symmetrical, and become more nodular, until we reach a gland with a single adenomatous mass (*Fig.* 241).

These transitional forms are not so few in number that they may be ignored; they are as numerous as those of the so-called exophthalmic or toxic adenoma type. I believe that we are dealing with one disease whose manifestations differ under differing conditions, and that these conditions depend upon factors some of which are well-defined and some of which are not yet clear, and that these factors are three. I propose to examine each, and to show the response to surgical treatment in some groups of cases in which the patients have reached an extreme degree of disability, and the reasons why

the response to surgical treatment is conditioned by the three etiological factors.

**Nomenclature.**—Parry described the disease accurately in 1786, Graves in 1836, and Basedow in 1840. I shall employ the words 'toxic goitre' to replace these names* and also the terms exophthalmic goitre and toxic adenoma, because the only two facts about which there can be no argument are, first, that there is a goitre, and, secondly, that there are evidences of toxicity referable to the goitre. The word 'hyperthyroidism'—that is, excess of normal secretion[3]—which occurs so constantly in the literature, may, or may not, express the condition present in some patients. With the evidence

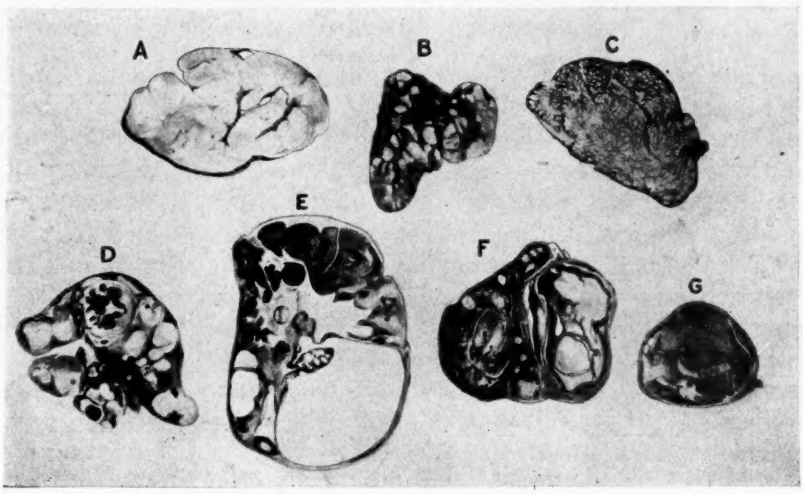



FIG. 241.—A series of specimens removed at operation, showing the gradation from primary toxic goitre (exophthalmic type) to secondary toxic goitre with a single nodule (toxic adenoma type).

A, Primary toxic goitre—bilateral, smooth (exophthalmic type). B, Secondary toxic goitre—early type—exophthalmos—bilateral—smooth—scattered areas of hyperplasia. C, Secondary toxic goitre—early type—exophthalmos—bilateral—smooth—no solid areas visible to the naked eye—appears completely colloid. (Patient, *Fig.* 256; sections, *Figs.* 252, 253, 254. D, Secondary toxic goitre—later type—bilateral, becoming nodular to palpation—no exophthalmos—auricular fibrillation for four years. E, Secondary toxic goitre—unilateral—very big, irregular masses—auricular fibrillation eight years—œdema extensive. F, Similar to E, but smaller and smoother. G, Secondary toxic goitre—one single smooth nodule—typical 'toxic adenoma' type.

at present available I emphatically believe that it does not, and that the disease throughout its whole range is a toxic state. Some qualifications of the term 'toxic goitre' will be necessary, but these qualifications need be only of the simplest, and employed in order to indicate whether the disease is a primary or a secondary condition, and whether, if secondary, the condition is an early or a late one. A 'secondary' condition implies that the thyroid

* The term 'exophthalmic goitre' is so descriptive, and both it and the name 'Graves' disease' are so firmly established, that they will certainly remain permanently; although if the disease is to be associated with the name of an individual, should it not be that of Parry?

gland has been the seat of a non-toxic goitre before toxic manifestations occurred. Throughout the literature of toxic goitre there has been much argument as to whether the disease is essentially of the thyroid gland[4] or whether the gland changes are part of a general disorder. Let me say at once that I believe that the stimuli which bring about the disease are situate without the gland, and that these stimuli affect the gland, causing such change in its structure and function that its secretion is altered, and consequently other organs are intoxicated by its altered secretion. The enlarged thyroid itself, together with the intoxication of the other organs, give us the manifestations of the disease.

**Three Primary Factors.** — We have therefore three factors present: (1) The stimuli; (2) The thyroid gland; (3) The organs affected by the disordered secretion.

*The First Factor: the Stimuli.*—A normal thyroid gland functions in response to normal stimuli in a properly balanced body. We have some evidence that normal stimuli can become excessive and therefore abnormal, and that these abnormal stimuli affect the thyroid gland detrimentally.

*The Second Factor: the Gland.*—An individual may have a gland which is normal; or a gland which has already become a colloid goitre, or which by successive waves of stimulation has passed through stages of hyperplasia and involution and become a nodular goitre; or an otherwise normal gland may contain an adenoma. These changes are frequently occurring apart from toxicity or before any question of toxicity arises; and on to a gland in any one of these states, or any combination of these states, there may be directed the pathological stimuli which constitute the first factor. The reaction of the thyroid gland to these stimuli must vary within limits according to the amount and condition of its own epithelial elements at the time.

*The Third Factor: the Cells of the Body.*—Plummer has well said that the energy output of the cells of the body is determined by the secretion of the thyroid gland. So sensitive are these cells to the amount and quality of thyroid secretion, that differences in the amount or quality produce results that are obvious, and whose nature is becoming increasingly well known to us. For the purpose of this discussion, instead of taking the cells of the body generally, I am confining myself chiefly to the muscle fibres of the heart, for the reason that the heart is an organ influenced by thyroid secretion in a manner that can be observed, and to a great extent measured. This third factor of the heart before it is affected may also vary within wide limits.

My thesis is that the variations in these three factors and their inter-relationships give a sufficient explanation of the different types of toxic goitre —why in youth and early adult life we have the picture described as exophthalmic goitre; why this type becomes less frequent with succeeding decades, although it never completely disappears; and why the type described as toxic adenoma rarely occurs in early adult life but becomes the increasingly predominant type in the later decades. Let us take the three factors in more detail.

### 1. FIRST FACTOR: THE STIMULI.

The origin of the abnormal stimuli that affect the thyroid gland has troubled the clinician since the earliest recognition of the disease, and still there is little certain evidence. We have elicited some facts; some things we can only suspect. Let us first take the facts:—

1. The gland contains iodine, and the administration of iodine can affect its histopathology and physiology. In the disease we are discussing, its administration can cause a striking change in the clinical picture. Iodine undoubtedly has a profound influence on the gland.[5–8]

2. Marine[9] showed years ago that a goitre could be produced in fish at will, and more recently McCarrison[10] has been able, by feeding experiments with deficiency of manganese, to create the histological picture of a pathological gland in approximately 25 per cent of cases (*Fig.* 242).

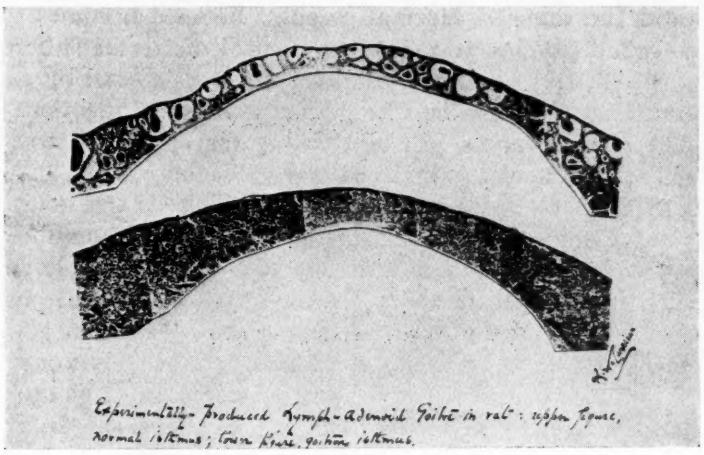


FIG. 242.—Experimentally produced lymphadenoid goitre in rat. Upper figure, normal isthmus; lower figure, goitrous isthmus. (*McCarrison.*)

3. Rupert Farrant[11] began to show, and Cole and Womach[12] have demonstrated, that acute infections quickly affect the histology of the gland. Add to this that an acute infection, such as tonsillitis, occurring in the course of the disease immediately sends up the pulse-rate and obviously increases the gravity of the other symptoms. I have seen a gain in weight of two stones follow the enucleation of infected tonsils during the course of the disease, and amelioration of the symptoms has repeatedly followed this procedure.

4. It is common knowledge that in some women visible enlargement of the gland occurs at the periods of physiological activity of the reproductive organs. We cannot doubt that an intimate relationship exists between the reproductive organs and the gland.

5. We know how psychic states can affect the disease. I have seen unhappy family life cause repeated exacerbations, finally ending in death, in a young person, and we have all seen the improvement that follows physical and mental rest.

Now we leave what we know, and consider what we can only suspect. What Marine and McCarrison achieve experimentally may be happening to anyone, and is certainly happening to some through unconscious diet deficiencies. There may be deficient intake of iodine or manganese, or indeed of other necessities which we know not of; or, even if there is an adequate intake, part of this may be deflected from its normal course and used up in such ways that sufficient never becomes available for the thyroid. Marine and McCarrison have not shown that the experimentally produced change in the histopathology of the gland is ever associated with thyrotoxicosis, but a gland such as they show has ceased to be a normal gland. Also there are added from time to time infections. The evidence is clear that these further damage the gland, and in some few these damages through lack of chemical balance, and through infections, may hinder the gland from standing up to subsequent strains. For in this world the subsequent stresses and strains come, and, in relation to this disease, two types of them are predominant: the psychic and the sexual. Normal cerebral balance becomes disturbed by what may be called psychic trauma—the mental distresses suffered by sensitive people; the mental conflict constantly undergone even by some who are not unduly sensitive, through the disorganization of the affections or business or health. Let me instance a girl of 18 who was compelled to live with an uncle who was very difficult. She lived in great unhappiness, and had no rest except when in hospital. We watched her through several exacerbations of the disease, and in one of these she died. These cases could be multiplied, but it is not necessary. Now consider sexual troubles. We have noted that sometimes the thyroid gland alters in size with menstrual periods. The development and control of sexual balance is not perfect in all of us. Our American colleagues have coined a suitable phrase—'sexual imbalance'. With some this may be absent, development and control going on perfectly and almost subconsciously. With others it is otherwise. In some it is a question of thwarted affection. I have seen young women in whom I am compelled to believe that the disease started when the parents continued to forbid an engagement. In others the difficulty is sexual urge. A surprising proportion of the men who have suffered from this disease have voluntarily told me of their mental turmoil. They live in an atmosphere of sexual introspection, and do not appear to obtain peace. I have never felt it wise to probe into these affairs, because I know of no remedy for our inherited desires.

I cannot tell you that these are the causes of Graves' disease.* Most people go through all these troubles without falling victims to the disease, but I have found one or another of them looming largely in most patients. The point I want to bring out at the moment is not the ultimate cause, but the incidence of the factors at the different periods of life. The food and chemical factor is present throughout life. Infections are always with us. The physiological stresses and the passions are strongest in the early years of adult life. The cerebral cortex reacts to them more intensely, and their effects are felt more keenly at this period. May this not be the reason why

* The disease does occur in early childhood. It is difficult to explain the origin of the pathological stimuli at this age.

primary Graves' disease is much more frequent in the earlier decades of life? (This point will be referred to again when discussing the variations in the 'second factor'—the thyroid gland). Do these passions cease with age? Not at all, but much of their intensity lessens. Business and family worries may be great. Even sexually we are told that there is a dangerous age, but fortunately more tranquillity, even calculation, comes with advancing years. For these reasons, primary Graves' disease can begin in the later decades of life, but in these later decades the primary disease is less frequent. When the primary disease does occur in later life it is, for reasons which will be given later, a much more serious condition.

### 2. SECOND FACTOR: THE THYROID GLAND.

Most people commence life with a normal thyroid (*Fig.* 243), but a diffuse colloid goitre may occur early in life (*Fig.* 244). This, as de Quervain[13] and others have shown, gradually begins to change into a nodular goitre about

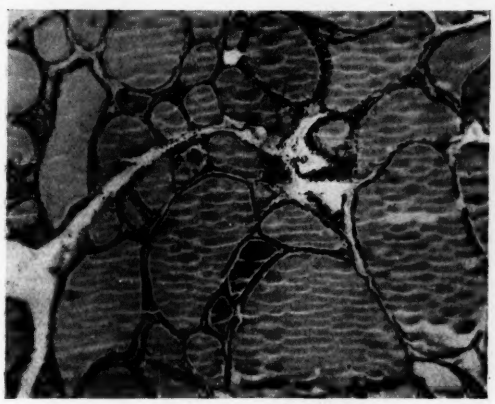


FIG. 243.—Normal thyroid.

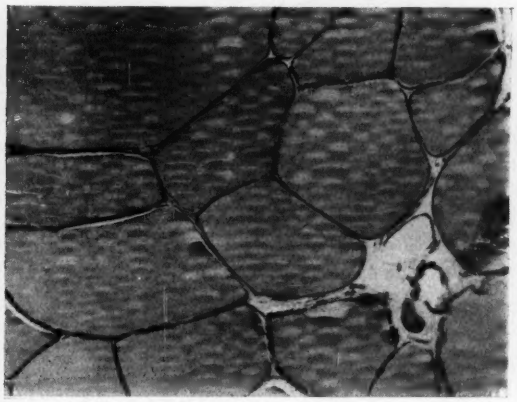


FIG. 244.—Colloid goitre.

the third decade (*Fig.* 245). Through the increase in the fibrosis, and localized hyperplasia followed by involution, this ultimately may become fibrocystic. Rienhoff and Dean Lewis[14] have elaborated this, showing further the development of colloid adenomas (*Fig.* 246).

FIG. 245.—Nodular goitre.

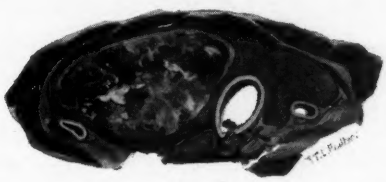


FIG. 246.—Colloid adenoma from a specimen obtained post mortem.

Again, a fœtal adenoma can exist in an otherwise normal thyroid gland. A gland in any one of these conditions may come under the influence of the

pathological stimuli which I have indicated as probably constituting the 'first factor' in the production of toxic goitre. The earlier in adult life this occurs, the more normal the thyroid epithelium will be; the later in life it occurs, the more likely is the gland epithelium and reticulum to have been affected already by waves of activity and involution. The gland may be in some stage of exhaustion. It is obvious that the histology of the thyroid gland, apart from any question of toxicity, may vary within wide limits. Its reaction to pathological stimulation must depend on its own condition when the stimulation begins to affect it. If the gland is a normal one, the whole gland can respond, and we see the picture which I have hitherto called a 'primary exophthalmic goitre' (*Figs.* 247, 248); which Scott Williamson and Pearse[2] have called an 'adenoid goitre'; which Wilson, Marine, Rienhoff, Dean Lewis, and many others have described, and

FIG. 247.—Primary toxic goitre (exophthalmic type): macroscopic.

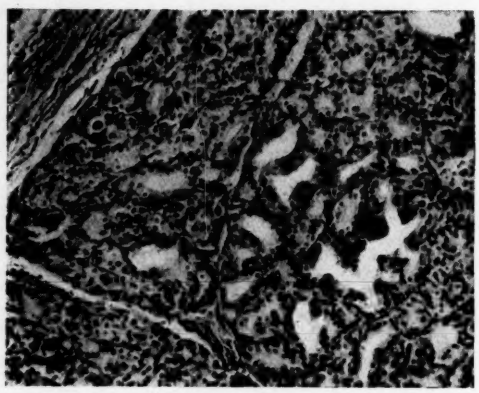


FIG. 248.—The same gland as shown in *Fig.* 247: microscopic.

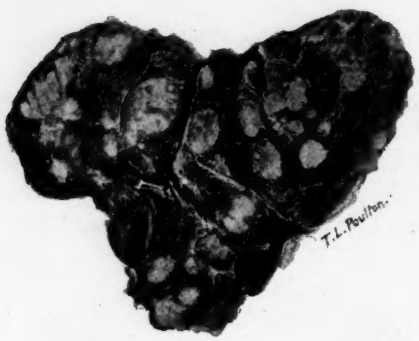


FIG. 249.—Secondary toxic goitre—early (exophthalmic): scattered areas of hyperplasia.

FIG. 250.—Secondary toxic goitre—early, apparently all colloid, exophthalmos. (Cf. *Figs.* 252, 253, 254, 256 from the same patient.)

which I now wish to call 'primary toxic goitre', or 'primary Graves' disease', or 'primary Basedow's disease'. If a thyroid gland is already in a state of colloid goitre when first affected by the stimuli constituting the first factor, its epithelium is already to some extent exhausted, and to some extent

destroyed. There is less of it, and what remains is incapable of reacting to the same extent as the normal gland could. Therefore we do not see the solid non-colloid gland which has been called primary exophthalmic goitre, yet the epithelium of the colloid goitre reacts to the stimulus to the extent to which it is able. But the macroscopic appearance will vary greatly; first according to whether the toxic change comes early or late after the occurrence of the colloid goitre, but also among patients at the same stages. There are

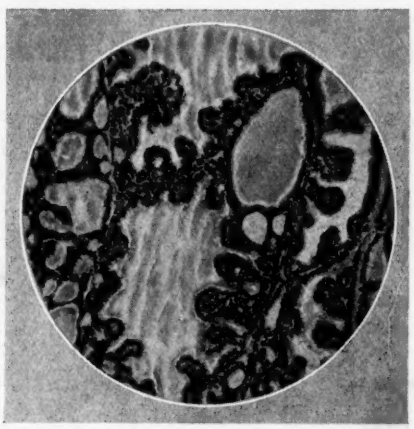


FIG. 251.—Secondary toxic goitre—exophthalmos. Lace-like type.

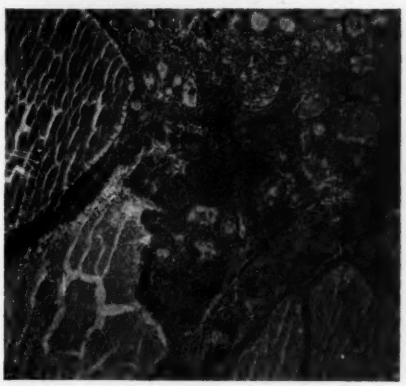


FIG. 252.—Secondary toxic goitre—early. Exophthalmos. Almost the whole gland consisted of large colloid vesicles with small scattered areas of hyperplasia. (Cf. *Figs.* 250, 253, 254, 256 from the same patient.)

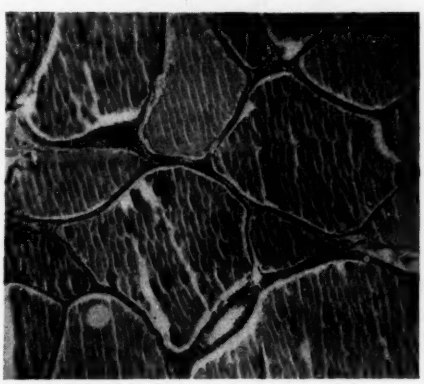


FIG. 253.—From the same patient as shown in *Figs.* 250, 252, 254, 256.

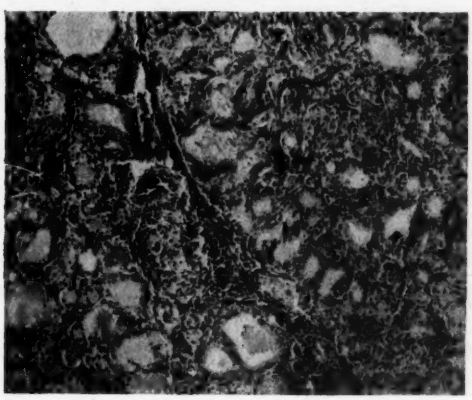


FIG. 254.—From the same patient as shown in *Figs.* 250, 252, 253, 256.

sometimes scattered solid areas of hyperplasia readily visible to the naked eye (*Fig.* 249). *Fig.* 250 shows one in which the whole gland appears to be still completely colloid, with no solid areas visible to the naked eye. Or the hyperplasia may be universal in the epithelium lining the vesicles—the type described as 'lace-like' by Rienhoff and Dean Lewis (*Fig.* 251).

*Fig.* 252 shows areas of hyperplasia in juxtaposition with large colloid vesicles. This is better shown in *Figs.* 253, 254, which are taken from different

parts of the same gland. These three sections are taken from the case shown in *Figs.* 250 and 256. They show how diverse the pathological picture may be. Occurring in young women, the clinical picture is scarcely distinguishable from that of the primary disease (*Figs.* 255, 256). This is because the stimulus is strong, and the thyroid epithelium is active enough to react to it. Why then call these other than primary Graves' (or Basedow's) disease? Because the history and the pathological examination show them to be secondary, and because they constitute the first link in the connecting chain between exophthalmic goitre and toxic adenoma. The second link occurs when a non-toxic colloid goitre has become nodular before it is affected

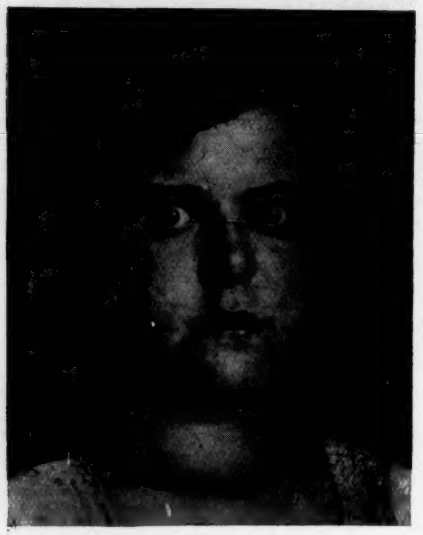


FIG. 255.—Early secondary toxic goitre: exophthalmic type.

FIG. 256.—Early secondary toxic goitre: exophthalmic type. The greater part of this gland appeared to be colloid goitre. (Cf. *Figs.* 250, 252, 253, 254.)

by the pathological stimulus. The diffuse, colloid, non-toxic goitre of the earlier decades evolves into the diffuse nodular goitre of the later decades, because hyperplasia becomes localized on account of the inevitable fibrosis. Hyperplasia, involution with colloid storage, colloid degeneration, and fibrosis may all go on together in different parts of the same gland (*see Fig.* 245). De Quervain,[13] Scott Williamson and Pearse,[2] Rienhoff and Dean Lewis,[14] and others have described the transitional changes. At any time during these stages the gland may be affected by the pathological stimuli which we have called the 'first factor'; but two points must be noted: Firstly, by the fourth decade (and a colloid goitre rarely becomes nodular before the beginning of the fourth decade) the pathological stimuli are much less intense, for the reasons I have previously stated, and there is much less thyroid epithelium capable of responding to the stimulus; also, what epithelium there is, is less active. The stimulus is less, and the reaction to the stimulus is less. Therefore exophthalmos and the symptoms due to the central nervous system tend

to be less, and often are absent, so much so that the disease at this stage has been described as a different disease—a toxic adenoma. The cardiovascular signs and symptoms predominate, for reasons that will be stated later. Allen Graham[15] and Rienhoff[14] have each described the evolution of the single nodule toxic goitre (*Fig* 257).

FIG. 257.—Late secondary toxic goitre, unilateral: toxic adenoma type.

It will be realized how great the variation in the 'second factor'—the thyroid gland—may be. It may be normal gland, colloid goitre, diffuse or unilateral nodular goitre; it may contain a colloid or a fœtal adenoma; it may be in any of these conditions, or in any transitional stage, when it is first affected by the 'first factor', the pathological stimuli. These two stages, the early and the late secondary toxic type, completely link the so-called exophthalmic goitre with the so-called toxic adenoma.

### 3. THIRD FACTOR: THE BODY CELLS.

As the example of the 'third factor' I take the muscle fibres of the heart. The reasons for this are that these cells are peculiarly sensitive to qualitative or quantitative changes in the thyroid secretion; that the manifestations are such that every clinician is familiar with them; that they progress from simple tachycardia to arrhythmia; that to a great extent they are subject to measurement; and that just as they progressively increase with the intensity of thyroid toxæmia, so return towards normal occurs with reduction in thyroid toxæmia. The young adult heart has great reserve power. Most individuals up to adult life and early middle age possess a heart with sound musculature, but by the fifth and sixth decades work, modern play, possibly child-bearing, influenza or other infective attacks, and age itself, have each contributed to the wear and tear of muscle fibre. The fact that mountain climbing, boat racing, deer stalking, and similar sports entailing heart strain have to be given up in middle age, drives home to us the fact that heart muscle can stand less than it could in youth and early adult life.

**Importance of the Variation in the 'Third Factor' (the Quality of the Heart Muscle).**—We have considered how the 'first factor'—the pathological stimuli—may vary within the widest limits; how the 'second factor'—the thyroid gland—may also vary within wide limits; how the 'third factor'—the body cells, of which at the moment we take as an example the muscle fibres of the heart—varies within equally wide limits before the impact of the altered thyroid secretion affects it. This altered secretion may be of high toxicity, but if the cardiac neuromuscular mechanism is young and unimpaired, tachycardia alone results, and, although this may be severe, the rhythm remains regular until, at long last, the reserve is broken down. If the heart muscle is older when the impact comes; if it is fourth, fifth, or sixth decade muscle; if, in addition, it has undergone the vicissitudes of

work, strenuous play, and, perchance, illnesses, life will have levied toll of its reserve, a slight degree of thyroid toxicity will break down its reserve, and irregularity of rhythm occurs early. If we look at the end-result we would say: "A very severe grade of intoxication." Not so: it may be a very slight grade of intoxication. The end-result is conditioned by the quality of the body cells on to which the intoxication is directed. The slighter degree of toxicity is the explanation of the infrequency with which eye phenomena occur — or the slighter degree to which they occur—in late secondary toxic goitre. In this late toxic goitre the 'first factor'—the pathological stimulus—is generally slight by comparison with its intensity in youth. It is directed on to a thyroid gland of which the parenchyma has been subject to involutional changes, the 'second factor' is at its minimum importance, and the resulting toxicity is therefore slight, so slight that it does not affect the eyes, and scarcely the central nervous system; but the worn heart muscle with its reserve used up fails, and fibrillation occurs. The minimum effect on the eyes and the central nervous system, and the maximum effect on the heart mechanism, does not imply a different disease; it is simply a difference in the ratio of the three factors.

FIG. 258.—Primary toxic goitre in an elderly person.

Nothing that I have said preclud the possibility of a primary toxic goitre occurring in late middle age. A stimulus of sufficient intensity, and thyroid epithelium free from involutional changes (both of which are less usual in late middle life), can and does produce it, but it occurs less frequently with advancing years (*Fig.* 258). In a case of proposed operation a sharp distinction must be drawn between fibrillation occurring in late secondary toxic goitre and fibrillation in an elderly person with primary toxic goitre. There is a great difference in the surgical risk.

We seek for truth. We have not yet found it. There is much to perplex us. Not infrequently the removal of a single nodule, leaving the remainder of the thyroid *in situ*, has resulted in the disappearance of tachycardia, cardiac irregularity, and œdema. There is hyperplasia within the nodule. How does stimulation affect the interior of the nodule and leave the remainder of the gland comparatively normal? Again, there is frequently hyperplasia in the tissue immediately surrounding the nodule. These facts for a long time made me subscribe to Plummer's view, but the steps in the gradation between these single nodules and the smooth symmetrical goitre of primary Graves' disease appear to me to be so complete clinically and pathologically that I cannot doubt that the view I have presented is more in accordance with the facts we are able to elicit in the present state of our knowledge. There are still many problems awaiting solution. Many writers have divided toxic

goitres into primary and secondary types. Some of the views put forward in this paper have been expressed by Allen Graham[15] in 1926, by Rienhoff[14] in 1927, by the writer[16] in 1927, and by Bérard[28] (Lyons) in 1929, each working independently. The absence of references to German work is due solely to my inability to read the language, but this article is in the main a record of personal views developed as the result of work carried out in the Surgical Professorial Unit at St. Bartholomew's Hospital. It does not contain a complete record of the literature of the subject.

## SURGICAL TREATMENT.

### PRELIMINARY CONSIDERATIONS.

It will have been realized from the evidence set forth in the first part of this paper that the disease is essentially the same whether the case is called primary or secondary, exophthalmic goitre or toxic adenoma, fully developed or *forme fruste*, any apparent differences being due to variation in one or more of the three 'factors' described. Nevertheless treatment must not be rigidly standardized, and must vary according to the clinical condition of the patient when the advice of the surgeon is first sought. I will state my usual practice briefly on the aspects about which there is little divergence of opinion, and discuss at greater length the question of auricular fibrillation, exophthalmos, permanence of results, extent of the operation required, preliminary treatment, and death-rate.

If the case is primary, operation is not performed in the earlier months. At this stage many patients recover with appropriate treatment; in some others the essential causes—the pathological stimuli—are still so active that operation would fail to achieve its maximum result. Septic foci are removed, adequate rest is given, and small doses of iodine are administered.* If the patient does not improve, or any sign of complication appears, operation is considered. The economic question is of importance. A well-to-do patient can afford time for rest, and may be willing to live a sheltered life with restricted activities, while a poor woman may be compelled to earn her living or manage her household. Visceral damage, while it may begin at any time in any patient, is therefore prone to occur earlier in the poor, and, both for economic reasons and to prevent or cure complications, operation must be performed earlier in the case of the poor. If operation is delayed too long, ultimate cure may be less complete.

If the disease is of the secondary type, nothing is gained by delay, and much may be lost. Operation should be performed as soon as the patient has been given sufficient preparation. This may be an arbitrary statement, seeing that the disease is essentially the same in each case; but when the disease is secondary, the thyroid gland has already been the seat of pathological change, therefore restoration to normal is less likely; also the patient is generally

* Some surgeons object to the use of iodine except in the pre-operative period. Iodine with other appropriate treatment is very beneficial in early cases. Its use cannot be denied to physicians. In a case where operation is obviously indicated it is wise to withhold it until twelve or fourteen days before the operation.

older, the heart muscle is older, and for these reasons cardiac decompensation occurs more quickly, even though the degree of intoxication is less.

This view of the wisest time for operation is a personal one, and there are still sharp differences of opinion. It is good for us as surgeons that some patients desire X-ray treatment, and that others wish to continue medical treatment when we consider that the time for these measures is past and that operation is essential, for in this way our beliefs are continually being tested. But certain statements in publications which cannot be ignored would seem to show a lack of knowledge of the degree of disability in which patients find themselves, or—if this is known—of what can be done to help them. Let me mention four:—

1. Kessel, Hyman and Landl,[17] state that with 'skilful neglect' the prognosis is excellent.

2. Barker[18] has stated that the course of the disease associated with diffuse hyperplasia of the whole gland—that is, primary Graves' disease—"is probably two or three years no matter how you treat it (medically, surgically, or radiologically)."

3. A surgeon[19] in a large provincial town in England very rightly asks, in a recent issue of the *Lancet*, "what the prognosis is in patients who decline operation", stating, *inter alia*, that "the patient is not interested in the percentages of deaths and recoveries. What she wants to know is the prognosis without operation in her individual case."

4. The authors[20] of Jacobson's *Surgery*, after a balanced discussion, raise the question whether the benefit to be obtained from the operative treatment justifies the risk which is necessarily run. This volume also raises another point which I wish to discuss later—the extent of the operation, if performed.

These are very legitimate questions to raise. They crystallize the aspects of the subject that are profitable for discussion, and they merit a detailed answer. (I wish everything I say to apply only to those patients who have failed to respond to medical treatment.)

The reasons for operation come under two headings: (*a*) Economic; (*b*) To prevent the grave complications of the disease, or to relieve them when present. Of the four published statements to which I have referred, the first three raise the economic question; the fourth the prevention and the cure of the grave complications. (We should use the term 'sequelæ' rather than 'complications', for in many cases these grave symptoms are inevitable sequelæ, not something accidental.)

Regarding questions 1 and 2. I have taken a consecutive series of 300 patients coming for operation, and divided them into groups showing the duration of the disease in years. These are not all cases of *primary* disease.

LENGTH OF SYMPTOMS.

| | | |
|---|---|---|
| Over 4 years | - | 125 patients |
| Over 6 years | - | 89 ,, |
| Over 10 years | - | 62 ,, |

and in 24 only was the history less than 4 years.

These 300 patients had had more than 'skilful neglect'. Each had sought the best treatment that, in her station, she was able to obtain. The result

for these patients has been great distress, and great economic loss for themselves, their families, and the community. I am keeping to facts, but in passing we should remember that of those who started level with this 300, we have no evidence how many recovered in Barker's two- or three-year period, nor, on the other hand, how many died.

Next, taking question 3. The writer states: "The patient is not interested in percentages of deaths and recoveries. She wishes to know the prognosis in cases where the patient declines operation." We all agree that some get well. A survey of the last 1000 patients operated upon by me reveals evidence of the condition in which many patients find themselves when operation has been delayed. I will mention briefly five groups: (1) Patients who develop eye complications other than exophthalmos; (2) Those who develop glycosuria; (3) Patients who develop mania; (4) Those who develop auricular fibrillation—many with cardiac decompensation; (5) Patients who die.

FIG. 259.—Chemosis and ulceration.

*Group* 1. *Eye Complications.*—I have had ten patients who developed corneal ulceration while still under treatment. *Fig.* 259 shows one in whom the conjunctiva was extruded to a degree in which it was ulcerated and almost strangulated. In some the eyelids were sutured together to prevent loss of the eyes, and separated when the danger was passed (*Figs.* 260 and 261). *Figs.* 262 and 263 show two patients in whom an eye was lost.

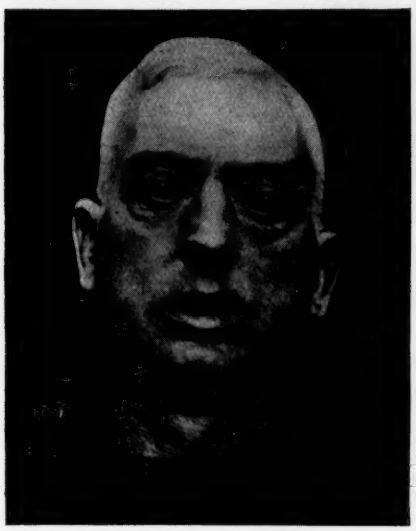


FIG. 260, 261.—In both these patients the eyelids were sutured together because of the imminent danger of loss of the eyes. In both, the eyes have receded following operation.

*Group* 2. *Glycosuria.*—Twenty-five patients have developed glycosuria, 9 of them very severely.

*Group* 3. *Mental Disturbance.*—Seventeen patients have developed mania. Five died in acute mania without operation; some developed chronic mania to an extent that made operation obviously unwise; some were operated upon while quite bad mentally. Only one who was operated upon failed to recover mental balance, and she had been in a lunatic asylum before operation—I did not know this at the time.

FIG. 262.—Loss of left eye.

*Group* 4. *Auricular Fibrillation.*—I have operated upon 131 patients with permanently established auricular fibrillation, and in most of these the disease had progressed to this condition while the patient was under observation and treatment.

*Group* 5. *Death.*—I have not kept a list of the patients who have died without operation, but I can recall 12 who on admission were either too ill for operation and died almost at once, or died while awaiting their turn for admission.

This is some answer to the question as to what the prognosis is in patients who have not been operated upon. Therefore I think we can take it that, after allowing for those who respond to other methods of treatment, some patients remain gravely ill, and for these some further service is required. Whether that service can be rendered by us as surgeons with a sufficient margin of safety is the question.

FIG. 263.—Loss of one eye.

## AURICULAR FIBRILLATION.

Let us take one complication occurring in this disease—established (continuous, not paroxysmal) auricular fibrillation. Auricular fibrillation frequently has other causes, and when due to these other causes is scarcely remediable. Even in this disease I am unaware of its disappearing after it has become completely and permanently established before it was shown that an adequate operation could bring about this result. Read[22] writes: "At this point it should be mentioned that one of the chief aims in the management of this disease is to prevent myocardial damage, which leads to decompensation and is the one residuum of this disease which is most distressing and from which there is often no recovery." He continues: "It sometimes

happens that the patient will be found at the first examination already to have auricular fibrillation. The prognosis in such cases developing auricular fibrillation early in the course of the disease is unfavourable for recovery."

When discussing etiology I selected the heart as an organ suitable for indicating the effects of toxicity, because the effect on the heart can be observed and measured by the electrocardiograph. In dealing with the surgery of the disease the heart again gives us one of the clearest indications of the result of treatment. For long it was held, and I know is still not uncommonly believed, that when auricular fibrillation is present, especially when it is associated with a goitre which may have diminished in size, there must have been an antecedent history of rheumatic fever, arteriosclerosis, or syphilis, and that one or other of these conditions, and not the goitre, is responsible for the fibrillation. And it was longer still before it was realized that when these conditions had been established for months or years the irregular heart rhythm could be restored to normal, and that patients with widespread œdema could be restored to active life by surgical operation. This condition has been stated repeatedly to be a contra-indication to operation. I operated upon the first patient of this type in 1908 and found that this complication did not add to the danger of the operation.[23] I continued to operate upon patients of this type[24] only with the idea of improving their general condition, for this improvement was very definite, and then in six patients in whom fibrillation had become permanent, normal rhythm returned spontaneously. There still remained others who, although greatly improved, did not regain normal rhythm.

The next stage began through my association with Professor Fraser in the Professorial Units of St. Bartholomew's Hospital. Fraser had been especially interested in heart problems, and had become accustomed to the use of quinidine with its powers and limitations. The position now is that with combined medical and surgical treatment, many patients whose hearts have fibrillated permanently even for many years—some of whom have œdema extending to the upper part of the trunk, others of whom have been bedridden for months—have been restored to a health level with normal heart rhythm and free from œdema. Shortly after normal rhythm has been restored, quinidine, if it has been used, may be stopped. Normal rhythm cannot be attained for more than a short time by quinidine if an inadequate operation has been performed. I will refer briefly to three of these patients: one to show the length of history, one the degree of persistent œdema, and one the severe chest condition present.

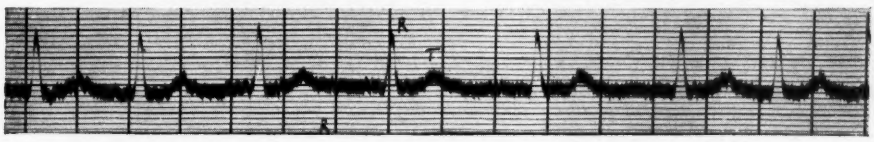


FIG. 264.—*Case* 1. Fibrillation of nineteen months' duration.

*Case* 1.—Suffered for thirteen years from goitre with palpitation. Ten years ago hysterectomy was performed for fibroids; immediately after this the palpitation became worse and was associated with great loss of weight and sweating. Eight

years ago the patient came to St. Bartholomew's Hospital, and has continued under medical treatment since. Nineteen months ago fibrillation began and has continued. Her electrocardiogram is shown in *Fig.* 264.

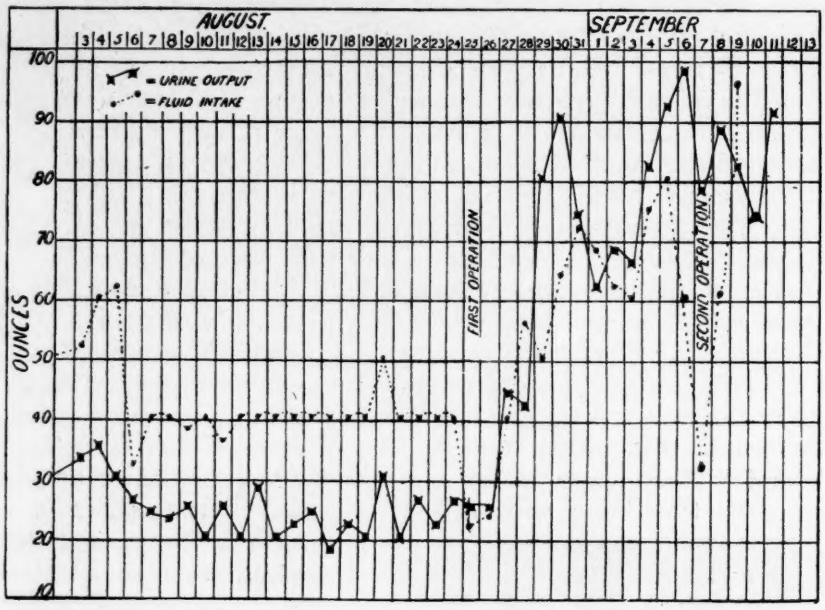



FIG. 265.—*Case* 2. Showing the output of urine for three weeks while under treatment with digitalis and diuretin, and the increase immediately following removal of part of the thyroid gland.

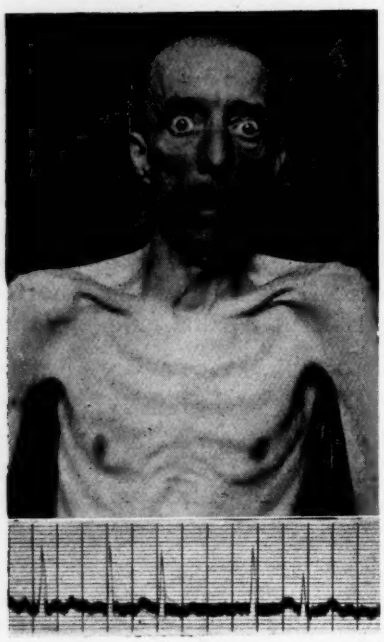
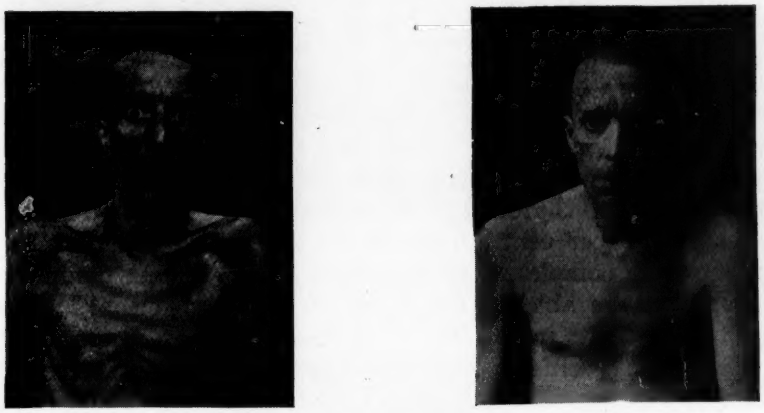


FIG. 266.—*Case* 3.

*Case* 2.—This patient had five years' continuous irregularity of heart rhythm with exophthalmos. She entered hospital with legs, thigh, and body œdematous; fluid in the abdominal and pleural cavities. The œdema of the thighs and the abdomen made it very difficult for her to be propped up in bed. The urine for three weeks was frequently down to one pint a day and never more than a few ounces above this. All known medical measures were used in hospital. The patient failed to respond and continued to lose ground. *Fig.* 265 shows the output of urine and the intake of fluid.

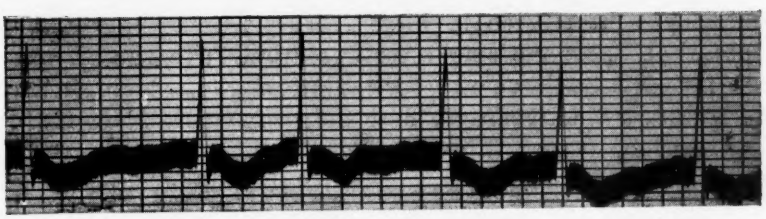
*Case* 3.—This man's bronchitis could not be brought under control even with long rest and treatment in the medical wards. It was partly dependent on his congestive heart failure. By ligating arteries one at a time, and subsequently dealing with each lobe on successive occasions, he was carried safely through. *Fig.* 266 shows his photograph and his electrocardiogram.

FIG. 267.—Photograph and electrocardiogram before and after operation.

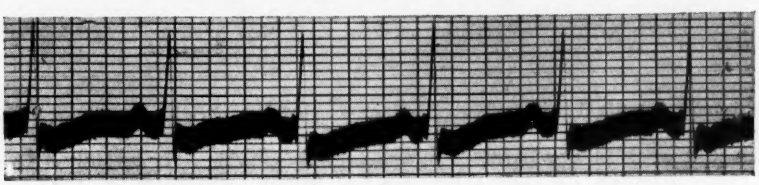


*a* *b*

FIG. 268.—*a*, Before operation; *b*, After operation.



*a*



*b*

FIG. 269.—Electrocardiogram of patient shown in *Fig.* 268—*a*, before operation; *b*, after operation.

I have taken a series of 100 consecutive patients with permanently established and continuous auricular fibrillation. I have not included those in whom *paroxysmal* fibrillation appeared to have become a permanent condition. *Figs.* 267, 268, 269, show electrocardiograms before and after operation, and photographs of the patients from whom these were obtained. It is interesting to see the decreasing pulse deficit following the second operation in a patient (*Fig.* 270). The first operation with subsequent medical treatment had failed to achieve this. Of these 100 patients regular rhythm has returned spontaneously in 48 after a sufficiently extensive operation. In 32 regular rhythm has returned after operation with the assistance of quinidine. Four felt so well after removal of one lobe that they were content to remain as they were; three of these four are living active lives; one died some years subsequently. In 7 who have had an adequate operation the heart has not yet returned to normal rhythm. Nine of the 100 have died following operation. This may seem to be high, but it should be remembered how very ill those who constitute this series were.* (The death-rate for partial thyroidectomy in toxic goitre when almost all risks are accepted is 2·7 per cent.) Should we not rather say that 81 per cent of people who were completely invalided have been almost completely cured, while 88 per cent are able to live lives very nearly normal? It would be idle to say that patients in this condition can be operated upon without risk, but the expectation of life in this class without operation is very low.

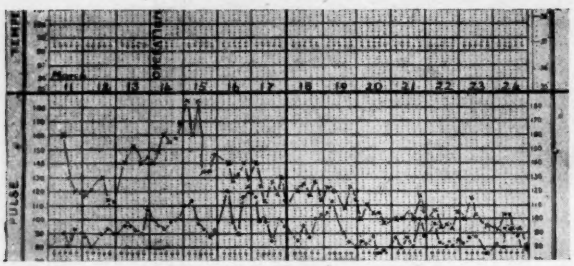



FIG. 270.—Decreasing pulse deficit following extirpation of an adequate amount of the second lobe.

Regarding the question of the permanency of the results obtained in this series of 100 patients, of the 81 in whom normal rhythm was restored, I believe only one has relapsed, and that was after six years of strenuous work, for this patient refused to limit her activities. It would be just as idle to state that these patients after operation have the physical reserves enjoyed by people who have not suffered from the disease. Almost all of them are living very active lives, and doing so with a degree of comfort which they had long ceased to expect.

Glycosuria and mental disturbance will be discussed on a subsequent occasion, but I must say something about exophthalmos.

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* In this respect Sir William Hale-White's[21] statistics should be remembered: Of 161 patients admitted to the medical wards of Guy's Hospital between 1888 and 1907, 18 died in hospital—just over 11 per cent. Undue weight should not be attached to these comparisons. Many patients in Hale-White's series would have been very ill on admission. Equally so were many in my series of fibrillators.

### EXOPHTHALMOS.

It is frequently stated that this sign remains even when the other symptoms improve. It always becomes less if an adequate operation has been performed, but it may remain to some extent. The amount of improvement that may occur is shown in *Figs.* 271–275.

*a* *b*

FIG. 271.—*a*, 1925. Before operation. *b*, 1929. After operation.

FIG. 272.—*a*, 1926. Before operation. *b*, 1929. After operation.

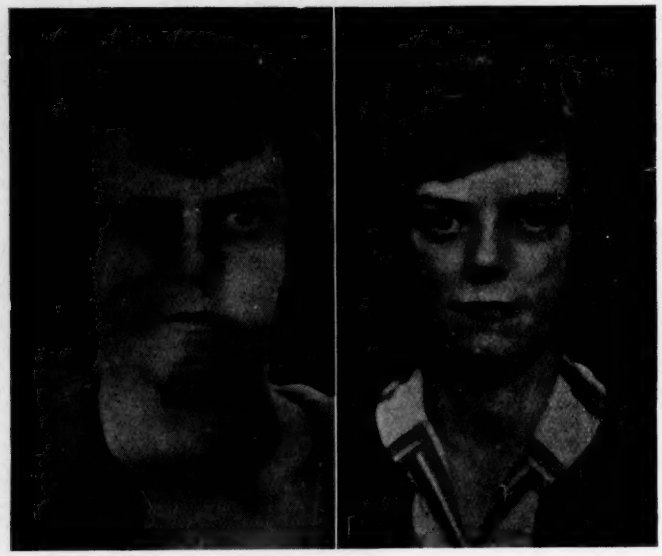

FIG. 273.—*a*, 1922. Before operation. *b*, 1926. After operation.

FIG. 274.—The left eye was lost owing to exophthalmos and ulceration. The left eye in the second picture is artificial.

FIG. 275.—The interval between these two pictures is only a few months. The exophthalmos, chemosis, and ulceration have disappeared. The œdema of the lower lids has not yet done so.

### THE EXTENT OF THE OPERATION REQUIRED.

In order that we may give this service to patients the operation must be adequate, and it must be reasonably safe. Regarding the extent of the operation required, Halstead,[29] in an article on "The Parathyroid Glandules: their Blood-supply and their Preservation in Operations upon the Thyroid Gland", states that the greater portion of both lobes may need to be removed in hypertrophy of the thyroid gland. Almost all the articles published in 1907–11 state that the extirpation of one lobe, together with the ligation of an artery of the opposite side, would cure 75 or 85 per cent of patients; and this belief is still expressed in some modern books.[20] By the end of 1907 I knew that my experience did not bear this out, and in 1908 I wrote[23] stating that it was essential to remove a sufficient amount of the second lobe before a patient could be cured. I published this again in 1909,[24] in 1910,[25] and in 1912.[26] I do not find other reference to partial extirpation of both lobes until the paper by Halstead[27] published in 1913.

A less extensive operation, even the ligation of an artery, may give surprisingly good temporary results, but these results are almost never permanent, and if any one thing more than another brings the operation into disrepute (apart from operating in unsuitable cases), it is an inadequate operation. The patient, after being allowed to expect that she will be better, finds that fibrillation, exophthalmos, rapid heart, tremor, hot skin—all the distressing symptoms—remain, or return after she has undergone a severe ordeal. She will be disappointed and annoyed, and so will her doctor. Three patients were admitted last year, each having had two operations performed, each having been led to believe that everything that could be done had been done, and that no more was possible, two of them with fibrillation still remaining, and all unable to work. In each there was a mass remaining, inconspicuous because it was deeply situated, and in each, on removal of an adequate amount of this, normal rhythm returned spontaneously. We should not be induced to operate upon a patient unless we have her assurance that she will let us complete, in stages, what may be necessary.

The matter of incomplete cure raises another question. Some patients with toxic goitre have, apart from it, an unstable nervous temperament, neurasthenia, visceroptosis, or other conditions which would prevent them feeling well under any circumstances. Operation upon these patients requires careful consideration.

There is also a class of patients with symptoms resembling those of this disease to some extent, but not due to toxic goitre. These patients are thin, perspire freely, and have a rapid pulse-rate. The thyroid gland is not enlarged. They are not suitable for operation.

### SAFETY OF OPERATION.

Regarding the safety of operation, and surgical management generally, I will say very little.

1. The death-rate of operation, taking all cases of toxic goitre, has been 2·7 per cent. If practically all risks are accepted, that is scarcely likely to be lowered.

2. In elderly people it makes a great difference whether the condition is primary or secondary. At this time of life the primary condition is rare compared to the secondary. The primary condition in an elderly patient is always a serious surgical risk. In the secondary condition the surgical risk is not as serious as would be expected from the signs and symptoms of the patient. It is to be remembered that whether primary or secondary the disease is essentially the same, but in the secondary type changes in the gland preceding the development of toxic symptoms have lessened the amount of active epithelium. There may be an extreme degree of cardiac decompensation, but the symptoms referable to the central nervous system are not so great, and it is the latter which give the danger to operation.

## MANAGEMENT OF PATIENTS.

**Iodine.**—The surgeons of the world owe a great debt to Henry Plummer for his work in discovering the measure of safety that is given to the operation through the administration of iodine in suitable doses. It has helped so greatly that the literature would lead us to believe that the operation is now quite safe, that the necessity for ligation of arteries has passed, and that generally the complete procedure may be performed in one stage. To some extent this is true, but it is not completely true. Plummer[6] pointed this out. His statement is that 37 per cent improved markedly and promptly, 32 per cent definitely, 11 per cent only slightly—about equal to what would be achieved by hospitalization and rest—and 5 per cent were not affected. All accurate observation confirms this view. The patients constituting the 11 per cent, and especially the 5 per cent, still remain dangerous risks. Unless this is recognized and the operation graded accordingly, the death-rate will be unduly high. Again, without doubt in elderly patients iodine treatment sometimes gives a false impression of safety.

**Special Cases.**—In the old and very ill, and the young and very ill, it is wise to ligate vessels at a preliminary operation, and, even then, to remove one lobe first.

## MORBIDITY FOLLOWING OPERATION.

Apart from the death-rate, the morbidity of operation must be taken into account. Injury to a recurrent laryngeal nerve is still a very present danger. I have had three severe cases of tetany in something over two thousand operations. This condition is very distressing. Two of these had had much X-ray treatment previously; the third had suffered from encephalitis lethargica. I simply record the facts. Halstead has shown that very occasionally the greater part of the parathyroid tissue may be situated within a lobe of the thyroid. I have once had a pulmonary infarct—non-fatal.

## RADIOTHERAPY.

**X-ray Treatment.**—Regarding X-ray treatment I have to suspend judgement to some extent. I know that some patients with this disease are relieved by it, but cannot say just how many. Dr. Finzi and the writer are watching

some patients together. I know of four young women decidedly better, and one man in whom I am interested whose treatment was controlled by Dr. George Murray is back at work after several years' illness. In another, where not quite enough gland had been removed, X-ray treatment made an incomplete success into a complete one. I have no doubt that radiologists see some patients upon whom I have operated who have not been completely cured. On the other hand, since 1921 at least 31 patients have been sent to me for operation who had been given what had been regarded as adequate X-ray treatment, and were, when they came to me, without doubt very ill people—most of them gravely ill. The X-ray treatment had not been given casually in remote districts. It had in the main been given under skilled supervision and in big centres. These 31 include patients from the age of 17 to 60. Some had been at complete rest in hospital during the period of treatment; others had able practitioners outside and treatment under conditions of their own choice as long as was considered necessary. Several of these improved while treatment was being given, but relapsed at once on cessation. With others the symptoms have been accentuated while under treatment, and many of the worst cases I have had with fibrillation and œdema had previously been treated by X rays. Burns still occur even under able supervision, and frequently the texture of the integuments has been so altered that when operation had to be performed healing was interfered with. I sometimes wonder whether the parathyroid glandules have their vitality lowered by X-ray treatment, for, as stated before, of the three patients who suffered from tetany subsequent to operation, two had received much X-ray treatment.

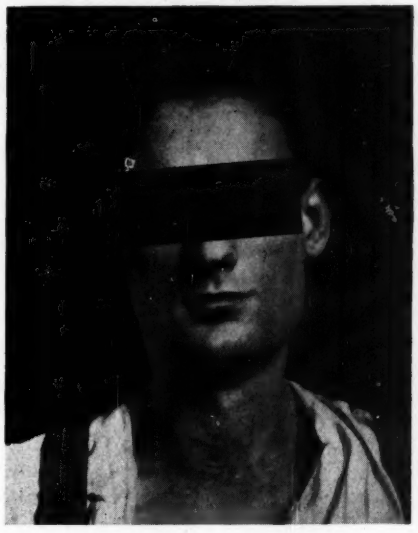

FIG. 276.—Damage to skin and deeper structures through injudicious X-ray treatment.

As a working rule I would suggest that X-ray treatment is inadvisable when any of the graver complications are present, or in elderly patients where cardiac decompensation is present or imminent. In young patients without complications and where time is not of importance, it may be used; but, as with all medical treatment, the results should be watched and other measures adopted if it fails. Especially should care be taken not to damage the skin. I become rather prejudiced because of the condition many patients are in when they are sent to me, where I cannot help thinking that the treatment has been persisted in too long, to the detriment of the patient. *Fig.* 276 is not shown in any controversial spirit, but patients still come in this condition. The morbidity of X-ray and medical treatment should be borne in mind as well as that of surgical treatment.

**Radium Treatment.**—After X rays one naturally thinks of radium. I have had four patients who had been given radium treatment. Two of them

were sent to me by the practitioners who had administered the treatment. All four were very ill when I saw them. None of them had improved, and two of the four had become alarmingly worse under the treatment. Notwithstanding this, further experience may prove radium treatment to be of value.

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# MULTIPLE POLYPOSIS OF THE COLON.

By JOHN H. ANDERSON and O. A. MARXER,
RUTHIN CASTLE, NORTH WALES.

Multiple polyposis of the colon has been described as far back as 1721, and as Sir William Wheeler[1] recently pointed out in this Journal, is not so rare a condition as was at one time supposed. In 1924 J. E. Struthers[2] reviewed twenty cases of multiple polyposis in the alimentary canal, mostly in the colon. The difficulty lies in the diagnosis and, as the symptoms are those of ulcerative colitis, the sigmoidoscope and X rays offer the only means of recognizing the condition short of opening the abdomen and colon. Radiographs of polyposis are hard to come by, and the following cases are recorded mainly because in each the diagnosis was made by X rays as well as by the sigmoidoscope; they show also that when the diseased area is beyond the reach of the sigmoidoscope the diagnosis may be made by the X-ray picture alone.

## CASE REPORTS.

*Case* 1.—A. B., male, age 61.

History.—One sister died from cancer of the rectum; another had ulcerative colitis and carcinoma of the cervix; one brother had ulcerative colitis. The patient had been constipated all his life. At the age of 38 he passed hæmorrhagic stools and suffered from loss of weight; the cæcum and part of the ascending colon were removed. At this time the pathologist reported that the bowel was enormously dilated with a thin atrophied wall. There was severe colitis again at the age of 57 and several mild attacks occurred later. In June, 1927 (three months before admission), the patient passed frequent stools containing mucus at first, and in August they became blood-stained. He gradually lost weight and appetite, and took no interest in his work.

On Admission.—He was admitted to Ruthin Castle in September, 1927, complaining of frequent colicky pains, with passage of flatus and liquid offensive stools, vomiting, thirst, loss of weight and strength.

On Examination.—The patient was undernourished and too ill to weigh, but was found to be 7 stone 10 lb. two months after admission. His skin was irregularly pigmented, the temperature 100·5°, pulse 105, the tongue dry and furred, with desquamation of epithelium on the dorsal surface. His abdomen was distended and gurgling; there were general tenderness and spasms of pain every fifteen to twenty minutes. He passed seven to twelve motions in twenty-four hours, the stools being black, liquid, and offensive; they contained blood, pus, and mucus, but no parasites were found or pathogenic organisms on culture. The blood-count was as follows: Hæmoglobin, 85 per cent; red cells, 3,600,000; white cells, 3800 per c.mm.; on differential count immature forms were numerous (70 per cent); eosinophils, generally normal (1 per cent), on one occasion rose to 6·5 per cent.

*X-ray Examination.*—Owing to the patient's condition full examination by an opaque meal was not possible. A barium enema filled the colon readily, all parts being capable of dilatation except the rectosigmoid junction, which was narrow and ragged. The ascending and transverse colon were dilated, showed inhibition, and tended to expel contents too quickly. In the descending colon and sigmoid there

was a lack of segmentation, the outline was ragged, and nodular filling defects, producing a honeycomb appearance, were present throughout (*Fig.* 277).

*Sigmoidoscopy* (E. I. Spriggs).—Mucous membrane acutely inflamed, swollen rugæ, passage narrowed at 13 cm. by a ring of polypi. One polyp was removed which the pathologist reported to be a small polypoid fold of large bowel mucosa, with engorged vessels supported by a fibro-inflammatory stroma, the gland tubules being in a state of secretory over-activity.

Diagnosis.—Ulcerative colitis with multiple polyposis of descending colon and sigmoid.

This patient did well under prolonged treatment (four months) and was able to resume work. In his case the polyposis seemed to be subsidiary to the ulcerative colitis in the production of symptoms.

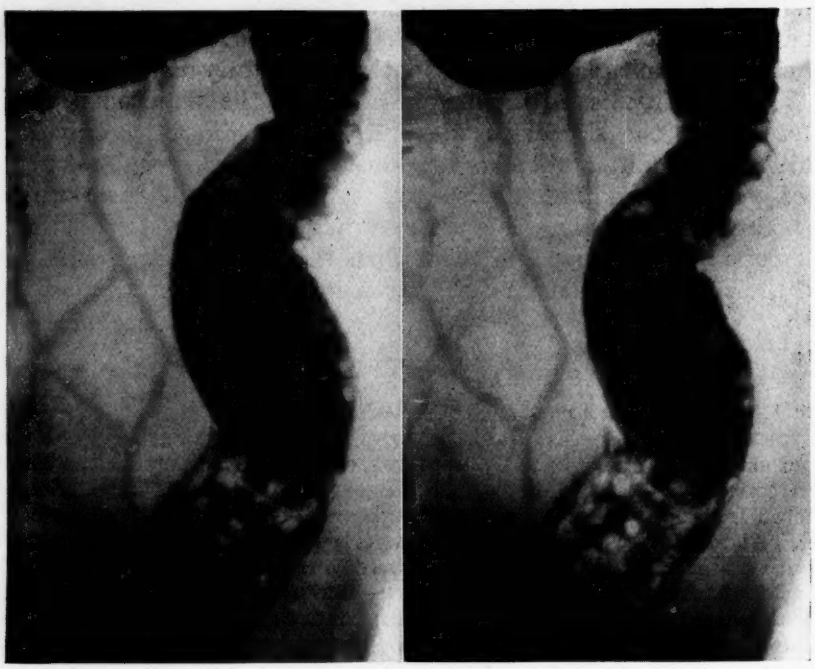

Fig. 277.—*Case* 1. Barium enema showing portion of sigmoid colon. The illustration on the right was taken one second later than the one on the left.

*Case* 2.—C. D., female, age 34.

History.—The family history showed no cancer or colitis. At the age of 23 the patient suffered from constipation; occasional bright blood with the stools, and tenesmus; the motions gradually became frequent, small, precipitate, and finally were mainly blood and mucus. She steadily lost strength, grew anæmic, and though the motions became larger they remained fluid. At the age of 29 she was admitted to a nursing home with profound anæmia, colic, frequent blood-stained stools, rapid pulse, and a temperature of 101°. The abdomen was opened in May, 1924, to perform an appendicostomy. The whole large bowel felt indurated and the transverse colon was red on its peritoneal surface and œdematous. Irrigation through the appendicostomy had to be stopped after a few weeks, as it was badly borne, but the patient slowly improved and was ultimately able to get about again. The next summer symptoms recurred with vomiting and pain severe enough to require morphia; this relapse was followed by slow improvement under treatment, the motions, however, remaining frequent and precipitate. Three years later, in August, 1928, symptoms again recurred, but did not yield to treatment.

ON ADMISSION.—The patient was admitted to Ruthin Castle in May, 1929, complaining of frequent motions, occasional vomiting, weakness, and breathlessness on any exertion.

ON EXAMINATION.—The patient was well nourished and weighed 8 stone 4½ lb., her lips were colourless and her sclerotics pearly. The pulse was 106, with frequent extrasystoles; the abdomen full, showing no tenderness and good muscular tone; the spleen was palpable, and the appendicostomy patent. The motions varied from seven to fifteen in the twenty-four hours; they were always precipitate and always contained blood, mucus, and pus; there was occasional tenesmus; the consistence varied from a large formed stool with streaks of darkish blood, to small motions, mainly clear or yellowish mucus, with specks of bright blood and fæcal material; non-hæmolytic streptococci were the chief organisms recovered on culture. The blood-count was as follows: Hæmoglobin, 28 per cent; red cells, 2,700,000;

FIG. 278.—*Case* 2. Barium meal showing colon eight hours after ingestion.

white cells, 5200 per cmm.; the differential count showed numerous immature forms (23·6 per cent), and normal eosinophils (2 per cent).

On the clinical evidence a tentative diagnosis of ulcerative colitis was made, and, though polyposis was not thought of, the following atypical points were noted: (1) The condition of the colon as seen at the operation five years before; (2) The patient's general nutrition and hearty appetite did not support long-standing colitis; in addition, her appearance suggested that the anæmia was due to hæmorrhage from a clean rather than from an infected area; (3) The skin of the abdomen had not the 'dead feel' of the colitic patient, and the stools were often formed and almost normal except for streaks of blood.

*X-ray Examination.*—Barium meal: the stomach was empty in four hours; the terminal ileum, the ascending and proximal part of the transverse colon were tender and expelled their contents more quickly than normal, barium reaching the

rectum within eight hours. The whole colon gave a honeycomb appearance with concave impressions on the margins (*Fig.* 278). This appearance was again seen with barium enema.

*Sigmoidoscopy* (E. I. Spriggs).—At about 6 cm. three small projections the size of a pea were seen, they were covered with mucous membrane and the tops were rounded ; a smaller one near by was like a short tail sticking up. At 13 cm. there was a small raised plaque, and just above this another projection about the size of a pea with three small convexities of the mucous membrane near it. (This appearance resembles that described and illustrated by Cuthbert Dukes.[3]) The instrument could not be passed beyond 16 cm. owing to a spasmodic contraction of the bowel. There was a slight redness of the mucous membrane, but the nodules had not the appearance of those round a cancerous stricture, and no ulceration was seen.

DIAGNOSIS.—Multiple polyposis of the colon with ulcerative colitis.

## X-RAY TECHNIQUE AND APPEARANCES.

Unless the radiologist is warned of the presence of colitis, the polyposis may be missed, owing to the rapid passage of the meal through the colon. Frequent examinations are necessary, and the general routine of the ordinary barium meal may require considerable modification. The barium enema in *Case* 2 was given fifteen minutes after a hypodermic injection of morphia (gr. $\frac{1}{6}$) and atropi nesulphate (gr. $\frac{1}{100}$). The material was run in at low pressure (18 in.) with the foot of the couch raised and the patient prone. She was asked to lie as still as possible and especially to resist the inclination to empty the bowel. With these precautions adequate time was given to get good films.

In polyposis the filled bowel is studded with concave impressions on the otherwise smooth margin, and the mucosa in general presents a mottled or honeycomb appearance, probably due to only a thin coating of opaque material being present in parts, owing to displacement by the polypi. If the bowel is too distended to show this mottling, pressure with a wooden spoon or air-bag may produce it. Serial films showed some exaggeration of the lesser movements of the colon, but frequent incomplete mass movements were present with a slowing of the relaxation phase and absence of segmentation. The nodular filling defects at the margins of the filled bowel and the honeycomb appearance of the colon as a whole are the main features in excluding uncomplicated colitis.

Polypi of the colon are of two types, inflammatory and true tumours, the latter being more frequently met with. J. H. Saint[4] describes the inflammatory polypi as " strips of mucous membrane which have become detached along almost their whole length, due to the undermining character of the ulceration." It is hard to imagine how structures of this nature can give the honeycomb appearance seen in *Figs.* 277 and 278. In fact it is uncertain whether inflammatory polypi can be diagnosed radiographically. In our opinion polypi of both types were present in *Case* 1, those seen in the lower bowel with the sigmoidoscope being inflammatory, and those shown in the descending colon and sigmoid by the X rays being true tumours. In *Case* 2 adenomatous tumours were demonstrated by both sigmoidoscope and X rays and there was no evidence regarding polypi of inflammatory origin. This

view is supported by the appearance of the mucous membrane adjoining the polypi; in *Case* 1 it was inflamed, but there was no evidence of disease in *Case* 2.

## SUMMARY AND COMMENTS.

1. Two cases of multiple polyposis of the colon are described in which the diagnosis was made by X rays as well as by sigmoidoscopy. The radiological appearances and technique are described and discussed.

2. In one instance the accompanying colitis was acute (*Case* 1), in the other it was chronic with exacerbations (*Case* 2). In *Case* 1 other members of the family had suffered from ulcerative colitis, cancer of the rectum, and cancer of the cervix, thus agreeing with the experiences of D. H. Pennant[5] and J. P. Lockhart-Mummery.[6]

3. The general colitic nature of *Case* 1, especially the stools, is contrasted with the clinical picture given by *Case* 2, in which it is surmised that the polypi were of longer standing, and they were thought to be true tumours rather than merely inflammatory in origin.

4. Whilst the anæmia was greater in *Case* 2 the nutrition was better. It would appear that polyposis gives rise to less abdominal pain and interferes less with nutrition than colitis but is more liable to cause bleeding.

5. In each case constipation was an early symptom, if not the earliest.

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# A REMARKABLE MECKEL'S DIVERTICULUM.

By H. BLACOW YATES,

ASSISTANT SURGEON TO THE SHEFFIELD ROYAL HOSPITAL.

The literature on Meckel's diverticulum is already voluminous, but the unique size of the one described below and its unusual anatomical position appeared to me to justify record.

History.—Beatrice S., age 37, of Killamarsh, near Sheffield, was admitted to the Sheffield Royal Hospital on March 1, 1928; she died on March 14.

The patient was admitted on account of severe abdominal distension, dyspnœa, and abdominal colicky pain. She stated that the abdomen had always been big, and was sure that it had always been larger than it should have been. She always suffered from constipation, and this and the distension had always been much worse during pregnancy. During the previous three months there had been a further increase in the size of the abdomen accompanied by great difficulty in getting the bowels to work. She had had severe colicky pain every day for a month and had felt sick; she had vomited a little during the week prior to admission. The bowels had only been opened every other day for a long time, and lately as many as five days had passed without a motion.

Recently the shortness of breath on exertion had become so bad that the patient had had great difficulty in walking up a hill and in performing the essential parts of her domestic work. She stated that the shortness of breath on exertion had troubled her for five or six years at least, and two years ago, when she was carrying her last child and was nearing term, it was exceptionally severe. She had had three children and there had always been severe trouble with distension of the abdomen during pregnancy, the patient thinking that she was pregnant with more than one child; but this had never been the case. The abdomen had never gone down completely after confinements as she thought it should have done. She was sure that the abdomen had gradually got larger each year. She had been 'unwell' in November, 1927, but apart from a little bleeding towards the end of January, 1928, she had seen nothing since. There had been difficulty in starting to pass water, this having troubled her during each pregnancy; but when not pregnant there had been no trouble of this kind and no frequency. She did not suffer from a cough and had not lost weight, though she had been thin for the past fifteen years except 'in the belly'.

On Examination.—The patient was a woman of thin type with a healthy complexion. There was no cyanosis or jaundice, and examination of the mouth was negative apart from some defective teeth. As she lay in bed she appeared to be comfortable when propped up, but when placed in the recumbent position she had difficulty in breathing. No adventitious

sounds could be heard in the chest, and the heart appeared to be free from abnormality.

The abdomen was enormously, uniformly distended, and through the thin, taut parietes peristalsis of small intestine type could be plainly seen. There was no evidence of any free fluid. To percussion the left half of the abdomen was hyper-resonant, whereas it was noted to be dull on the right. A lump could be felt in the hypogastric and left iliac regions rising out of the pelvis and with a rounded upper end. It did not disappear after catheterization and was apparently a uterine swelling This was not dull to percussion. Examination of the abdomen was extremely difficult on account of the marked distension. No tenderness was present and no fluid thrill elicited.

Mr. J. Chisholm very kindly examined the woman for me and his report on the pelvic swelling was as follows :—

"The patient's history of amenorrhœa varies slightly from the history she has given to you. She says she was unwell in November and also in December and bled for one day on Jan. 7. There is a curious rounded swelling rising above Poupart's ligament on the left side with some slight resistance to the right of this. The cervix uteri is softened and cyanosed. I think the swelling is an enlarged, misplaced uterus—size (?) 4 months, not tender or fixed. Nil felt extra-uterine. Examination is not easy."

No secretion could be obtained on squeezing the breasts. Rectal examination, after several enemata had been given, proved negative.

The woman was plainly suffering from chronic intestinal obstruction and was probably about three or four months pregnant. Whatever the cause of the obstruction, it was evident from the patient's clear history that the marked abdominal distension had not suddenly appeared but had slowly been increasing for years. The distension had become so severe two years ago that by the time she reached the end of pregnancy severe symptoms had resulted from pressure on the diaphragm. Now, at the period of three months, she had already symptoms referable to pressure on the diaphragm and bladder. It was extremely difficult to make a diagnosis of the cause of the distension and the associated chronic small intestinal obstruction. It was considered most probable that there had been a tuberculous peritonitis with a loculated collection of fluid on the right side. If this was correct, then the obstructive symptoms presumably were the result of adhesions. The uterus had been by some means displaced to the left side of the pelvis.

The patient was given extra fluids for a week by proctolysis and hypodermoclysis. Glucose was added to the rectal salines. (She had been afraid to take food freely for the past three months, as she was sure that this caused the abdominal pain.) A barium meal examination was not made, as it did not appear at the time that it would be likely to throw further light on the case. In view of the operative findings I regret that this was not done.

Operation (March 7, 1928).—The abdomen was opened by a paramedian incision from the umbilicus to the pubis. The wound had been first infiltrated by novocain, and when the abdomen was opened ether was given. The hand passed into the pelvis immediately found a pregnant uterus of three to four months' gestation. The coils of small intestine were slightly distended, but

not so markedly as one had expected to find them. The hand then encountered a large tumour extending from the right iliac fossa to the liver above and filling the whole right half of the abdomen. Its lower end was in contact with the enlarged uterus, but between them—on the right side of the uterus—descended the sigmoid colon. The liver appeared to be displaced over towards the left side of the upper abdomen. The huge mass was covered by peritoneum on the anterior surface and on the right side; here the peritoneum became reflected on the parietes. On the left side the omentum was adherent to and obscured this surface. The posterior surface was lying directly upon the posterior abdominal wall. The upper end of the tumour was rounded and so firmly pressed against the liver that the hand could not be inserted between them. The liver was decidedly elevated by the swelling. The tumour wall was typical of an enormously distended piece of bowel. It contained material of putty-like consistency, since it pitted on pressure of the finger and these dinted pressure areas showed no tendency to fill out when the pressure had been removed. The cæcum was lying to the left side of the lower end of the tumour with the ascending colon running vertically upwards in the mid-line of the body (*Fig.* 279). The lower end of the distended pouch of bowel narrowed somewhat and overlapped the right pelvic brim. Here it became continuous with a coil of intestine which ran straight into the hypertrophied and slightly distended last coil of the ileum. The ileum also communicated with the cæcum. The terminal two inches (it seemed no longer than this as the condition was seen at operation) of the ileum communicated with this portion of small gut as shown in *Fig.* 279. The ileum appeared to run almost directly into the lower end of the pouch, and a short piece of bowel, leaving this at an angle, entered the cæcum. It was plain that the ileum ran from X to Y and so through the ileocæcal valve into the cæcum, but the communication Z with the huge pouch had caused an angulation at the junction of X and Y. The lower end of the pouch appeared to have a longitudinal band on its anterior surface which gradually disappeared as it ascended the pouch. This gave the lower end of the pouch a close resemblance to large gut.

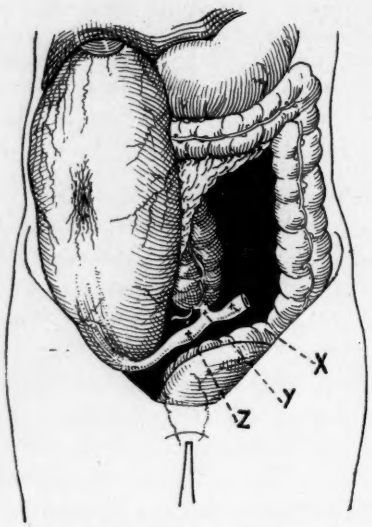

FIG. 279.—Findings at operation.

It was not easy to make out the exact state of affairs in this region between the enlarged uterus in the pelvis and lower end of this enormously distended piece of bowel. Neither Mr. Chisholm (who very kindly assisted) nor I had knowledge of such a condition having been encountered before. Removal of the huge sac, firmly adherent posteriorly, was clearly out of the question. We both felt it was most likely to be an enormous Meckel's diverticulum, but its size, position, fixation, solid fæcal contents free from flatus, and its communication with the ileum, apparently within a couple of inches

of the ileocæcal valve, appeared to us peculiar. The semblance of a longitudinal band also added to the confusion.

The patient was taking the anæsthetic very badly and breathing was very laboured. It was plain that above all an attempt had to be made to drain the huge fæces-laden sac. The sigmoid was adjacent to the lower end

FIG. 280.—Drawing of the diverticulum made at autopsy. It clearly shows the large size of the pouch, the small thoracic capacity, and the mode of termination of the ileum.

of the sac and this was laterally anastomosed (with no little difficulty) to the lower end of the sac and a rectal tube passed up to the anastomosis from the anus. The abdomen was closed and the patient returned to bed. We now felt sure that the sac must be an unusually large Meckel's diverticulum, the contents of which must have been slowly accumulating for years.

SUBSEQUENT PROGRESS.—The progress after operation was as follows :—

March 8.—The pulse was thin but only 84. Propped up in bed the patient looked comfortable, but breathing was more difficult than before the operation. Temperature 98°.

March 9.—She was much the same. The abdominal distension did not appear, however, to be any less, and there had been no improvement in the breathing. Temperature 98°, pulse 100.

March 12.—The wound was clean and the clips were removed. She was, however, weaker. There had been no vomiting since the morning following operation. She had a slight cough and laboured breathing. Temperature 98·2°, pulse 112, respiration 30.

March 13.—In the evening she aborted and was delivered of a four-months fœtus. Previously the bowels had been opened and flatus freely passed. After the abortion the pulse became much faster, 136, and she rapidly worsened.

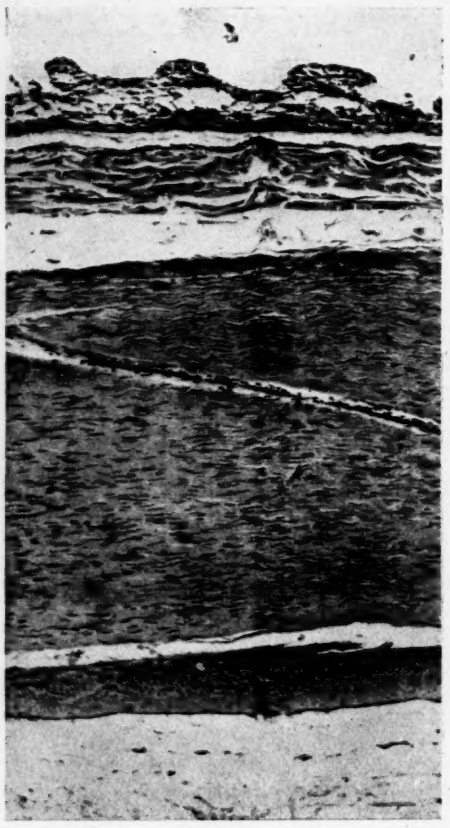

Fig. 281.—Transverse section of wall of diverticulum.

March 14.—She remained extremely ill without responding to the usual stimulating measures (including blood transfusion), and died in the early hours of March 15, the eighth post-operative day.

Post-mortem Findings.—The coloured drawing (*Fig.* 280) most clearly depicts the state of affairs met with at the autopsy; it is reproduced from a drawing which Miss E. M. Wright made in the post-mortem room. When this was done the parts had not been disturbed (beyond bringing the ileo-cæcal region to the surface in order the more clearly to depict the anatomical arrangement in this area). The painting shows the size of the Meckel's diverticulum (the omentum adherent to its left side had been separated and cut away) and how it had by gradual growth displaced the abdominal organs into the left half of the abdominal cavity. The extreme elevation of the diaphragm makes the thoracic capacity extremely small compared with the size of the abdominal cavity. It is at once obvious that the pulmonary vital capacity must have been very small indeed and the action of both the lungs and the heart seriously encumbered. There was no peritonitis around the sigmoid anastomosis to the diverticulum (not depicted). The lungs were markedly congested. So far as I could make out the anastomosis had failed to produce any evacuation of the contents of the diverticulum. The diverticulum was firmly fixed over

its entire extent to the back of the abdominal cavity, and in removing it I had to cut its posterior adhesions with a scalpel. There was no evidence of any persisting peritoneum posteriorly. The pouch was filled by solid fæcal material and no gas or fluid material was present. Its communication with the ileum was firmly ligatured and the diverticulum after removal was found to weigh *six pounds four ounces*. Death appeared to have been due to post-operative pulmonary congestion producing syncope. The abortion was an additional factor.

The specimen was sent to the Sheffield University Pathological Department; Dr. H. W. Gleave has carefully examined it and given me the following report and microphotograph (*Fig* 281):—

Specimen received March 16, 1928. At a distance of 8 cm. above the ileocæcal valve the ileum shows an acute kink, and from the antimesenteric border a huge diverticulum is given off. Proximally this is of the same diameter as the ileum, but it enlarges at first gradually and then abruptly into a large pouch as seen in the sketch. The length of the diverticulum is 56 cm., the greatest diameter 17 cm., the circumference 50 cm. The upper end is blunt and closed. There is a smooth peritoneal coat except posteriorily, where there is a mesentery carrying blood-vessels and containing fatty tissue. There is also a small amount of fat visible beneath the peritoneum of the diverticulum. Near the lower end a lateral anastomosis to the sigmoid colon has been made. The contents consist of brown fæces of the consistency of putty. The inner aspect shows a smooth mucous membrane with no local thickenings. There is no valve at the junction of the diverticulum and ileum.

*Microscopically*, sections from various parts show the structure of a Meckel's diverticulum. There is a low mucous membrane with glands, resembling that of the small intestine, a muscularis mucosæ, and circular and longitudinal muscle coats. Except for great hypertrophy of the muscle, especially the circular muscle, the appearance exactly corresponds with that of a Meckel's diverticulum 12 cm. long from the Museum. Scanty lymphoid tissue is present in the mucosa. No nodules of pancreatic tissue are seen. A comparison with sections of the wall of the ileum shows that both muscular coats of the diverticulum are in general about five times the thickness of those of the ileum. (The specimen was fixed by distension in formol saline.) The only pathological feature found is in the mucosa, where the blood-vessels are engorged and there is a small amount of lymphocytic infiltration.

## COMMENTS.

In a survey of the available literature I have been unable to find any description of a Meckel's diverticulum of such dimensions as the one described above. Philip Turner[1] in 1906 collected 360 cases of Meckel's diverticulum, but not one was of large size. They conformed to the well-known varieties. Bilton Pollard[2] describes a Meckel's diverticulum of remarkable length, 36 in., but it had roughly the same diameter as the ileum from which it arose, and fell into the group of cases formerly recorded under the heading of 'duplication of the intestine'. It is possible that a case similar to the one I have here recorded has been described before, but if so, I have failed to find it in the voluminous literature which has been written on this interesting congenital abnormality. Several writers on this subject have described instances of Meckel's diverticula possessing club-shaped ends (e.g., Klemp). J. Playfair McMurrich and F. F. Tidesdale[3] describe a diverticulum arising from the terminal ileum at its mesenteric attachment and ending in the region of the hepatic flexure of the colon in a bulbous-ended expansion 10 by 6 cm. in

diameter. The proximal tubal part, however, is of the same diameter as the ileum and 104 cm. in length. In discussing the formation of the unusual types of Meckel's diverticulum, the writers make the suggestion that they may represent the entire yolk sac. They suggest that when the primary loop of the intestine returns to the abdominal cavity during the early period of embryological development it may, in very rare instances, drag with it the vitelline duct and the entire yolk sac. It may be that this is the explanation of the origin of the large diverticulum I have described above—in other words, the diverticulum may be the entire yolk sac.

Neither pancreatic tissue nor gastric mucosa was found in the areas of the wall examined by Dr. Gleave. This may be due to the fact that these, if present at all, were in portions of the wall not microscopically examined. According to Schartz,[4] pancreatic tissue is found in only 10 per cent and gastric mucosa in 16 per cent of cases examined carefully.

If I should ever meet such a case again—which is unlikely—I feel that the best treatment would be to divide the communication between the diverticulum and the terminal ileum and drain the sac through a stab-opening in the loin posteriorly. The drainage even then would be slow and would probably need the help of lavage. A permanent mucous fistula might ensue, but I do not consider that any form of internal drainage by anastomosis would drain effectively a Meckel's diverticulum of this type.

I wish to express my sincere thanks to Dr. Gleave for his pathological report on the specimen and for the microphotograph; to Mr. Chisholm for his kindly help; and to Miss E. M. Wright for the excellent painting.

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# STRANGULATED INTERNAL HERNIA IN A RETRO-APPENDICULAR PARACÆCAL POUCH.

By CHARLES DONALD,

SURGICAL FIRST ASSISTANT AND REGISTRAR AT THE LONDON HOSPITAL.

Much discussion has taken place over the various pericæcal peritoneal fossæ and their development, and even more over the question of their liability to cause strangulation of gut. Most interest centres on the ileo-appendicular pouch (the inferior ileocæcal of Treves and others), as it is difficult to conceive how such a small fossa could snare gut—the ileocolic is always too small to do so and is only of anatomical interest; and while there are authentic cases recorded by Nasse[1] and Riese[2] of strangulation of short portions, other cases in which large loops have been reported as incarcerated seem less possible.

The case to be recorded discloses another pouch in the same location formed by lack of fusion between the mesocolon and the posterior parietal peritoneum in the terminal stage of embryological rotation of the intestine. Its size and its capability of becoming larger by distension from within, possibly throw some light on these large herniæ which, without the advantage of a post-mortem dissection, have been termed ileo-appendicular. I can find no previous description of this fossa. An additional interest is to be noted in the presence of a 'retroperitoneal' position of the vermiform appendix.

## CASE REPORT.

A man, age 57, was admitted to the London Hospital in September, 1928, with a history of four days' abdominal pain originating in the umbilical region but shifting later to the right iliac fossa. Vomiting, at first bilious and then stercoraceous, was frequent. An accurate history of bowel movements was not procured.

On Examination.—The patient was extremely ill, the pulse 140, and the temperature 100·5°. The abdomen was slightly distended, with no rigidity except in the right iliac fossa, where moderate resistance was accompanied by some deep tenderness and an indefinite lump was palpable. A diagnosis of acute obstruction of the small intestine was made.

Operation.—At operation congested and moderately distended small intestine was traced to an opening behind the ileocæcal junction, where both entering and leaving loops could be detected. The lower small intestine, cæcum, and large gut were collapsed. Fully a foot of small intestine was easily withdrawn from the opening and was found to be moderately congested and dilated, with well-marked constriction rings at either end. The loop quickly regained its colour and the constriction rings also seemed capable of spontaneous recovery. The operation was then finished as quickly as possible. The patient died two hours later.

Post-mortem Findings (*Figs.* 282, 283).—The hernial pouch, measuring 10 by 9 cm. in the collapsed state, lies to the inner side of the ascending colon just above the ileocæcal junction and external to the line of attachment of the mesentery proper. The anterior wall of the sac is transparently thin and vascular and has fused to it posteriorly the appendix, which points spleenwards. The ascending colon, although

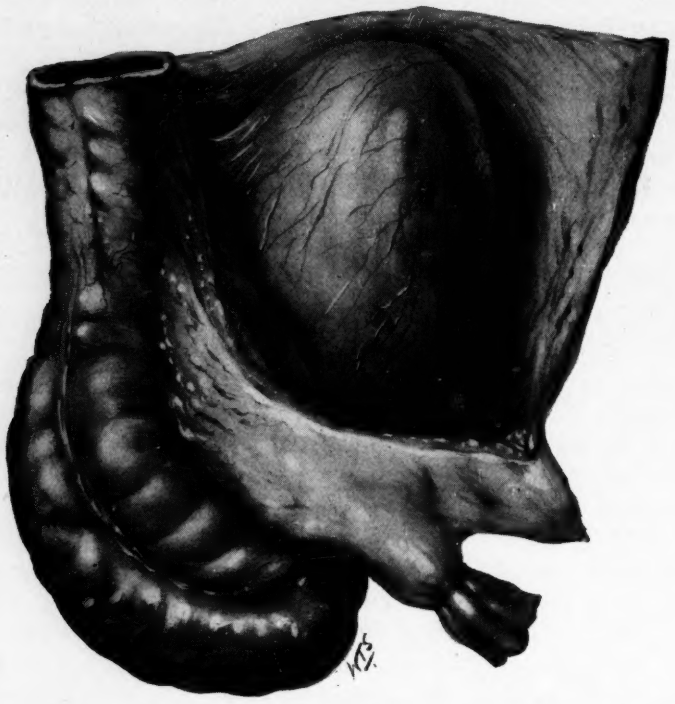

FIG. 282.—Post-mortem specimen showing the internal hernial pouch which has been distended with cotton-wool introduced through the opening seen in *Fig.* 283. The tip of the appendix can be detected showing through the anterior wall. The specimen has been spread out and the attachment of the mesentery proper does not show, being further to the left.

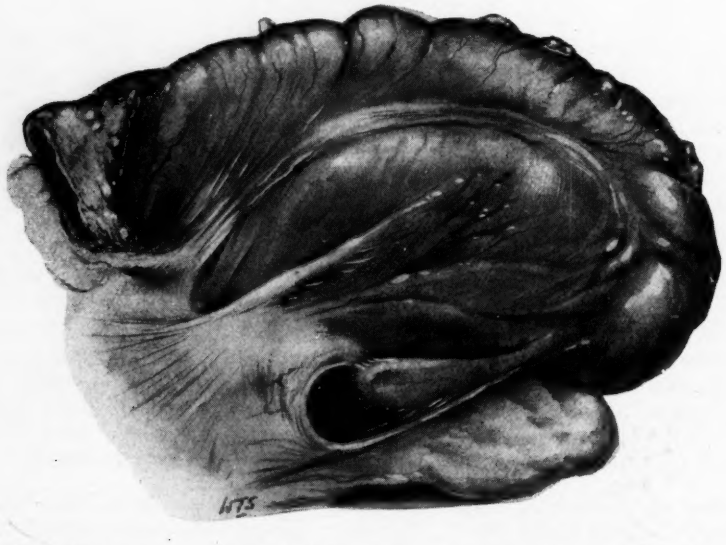

FIG. 283.—The cæcum and terminal ileum have been turned upwards and to the left to display the entrance to the sac. The opening of the ileo-appendicular fossa proper can be seen as the more darkly shaded part below it.

fixed by its inner border so that the pouch never becomes retrocolic, is otherwise free posteriorly, allowing colon and cæcum to be turned upwards and to the left, as in *Fig.* 283, to disclose the hernial opening. The opening (1·5 cm. in diameter) has for its anterior margin a straight fold passing from the cæcum at the base of the appendix to the parietal peritoneum of the iliac fossa. The posterior margin is a crescentic fold attached below to the anterior fold and above to the appendix about two inches from its base.

An ileo-appendicular fossa admitting two fingers is also present, the ileo-appendicular fold running from the terminal two inches of ileum to the appendix itself in so far as that process is outside the sac (*see Fig.* 283), and then losing itself on the anterior margin of the hernial opening. This fossa is funnel-shaped with a wide entrance, and the walls are overladen with fat of little strength.

Further dissection shows that the posterior wall of the sac supports only a few fine vessels, being relatively avascular compared with the anterior wall.

The loop of intestine which had formed the sac contents was found to be sixteen inches long and derived from the ileum about five feet above the ileocæcal valve. It was marked at one end by a distinct and at the other by a rather indistinct anæmic constriction, and showed ill-defined areas of hæmorrhage with some fibrinous peritonitis. There was collapse of intestine below this and distension above.

## COMMENTS.

The paracæcal peritoneal fossæ described by Lord Moynihan[3] in his classical work on retroperitoneal hernia are the ileocolic and ileo-appendicular fossæ (the superior and inferior ileocæcal fossæ of Treves and others), the retrocæcal fossa, the fossa of Hartmann, and the fossa iliaco-subfascialis. Rendle Short,[4] in collecting cases subsequently reported, has described another form with the opening on the outer side and the fossa behind the cæcum. Neither mentions the fossa here discussed. The most similar description is Lockwood and Rolleston's[5] previous description of an ileocæcal fossa which they found frequently situated behind the angle of junction of ileum and cæcum, running for a varying distance upwards behind the ileocolic junction and parallel to the ascending colon. So far the description tallies, but then they go on to give its right boundary as the mesentery of the ascending colon and its left as the mesentery proper, and say that it is frequently complicated by two folds, the mesentery of the appendix and the ileocæcal fold. It is obvious therefore that they were describing a larger form of the ileo-appendicular fossa, and thus Lord Moynihan has grouped their ileocæcal fossa as such.

The genesis of the fossa here described is apparently failure of fusion of the ascending mesocolon with the parietal peritoneum in the terminal stage of rotation of the gut. Its formation is therefore similar to that of an intersigmoid fossa on the left side. According to Frazer and Robbins[6] fixation of the mesocolon, in a general way, spreads peripherally. In this instance it has been interrupted, probably by the position of the appendix. It is likely then that the hernial opening was kept patent by the pull of a cæcum always changing in volume and that this stress has also given rise to the firmness of its margins. The interrupted process is much less common than the state in which fixation stops short, the latter leading to the terminal ileum and ascending colon being on a common mesentery and thereby predisposed to volvulus.

Stich[7] has described a strangulated hernia in the ileo-appendicular fossa in which two metres of gut were implicated. The diagram he gives from his

impressions at operation reveals a pouch in the same position as the one just recorded, only larger, which he describes as lying in a cavity somewhat above the cæcum between the vermiform process and the ileocæcal junction. It would seem very unlikely that an ileo-appendicular fossa should dilate to such a capacity, and although the appendix in his case was not within the sac there is no reason why failure of peritoneal fusion should not be the more probable cause of such a large pouch.

The case also furnishes an example of a 'retroperitoneal' appendix, and it is interesting to speculate on the ready-made limitation of any effusion should acute appendicitis ever have occurred, which advantage might have been counterbalanced by the difficulty of finding the offending organ.

## SUMMARY.

A retroperitoneal fossa lying in the ileocolic angle is described. It is distinct from the ileo-appendicular fossa, which is also present. It contains the appendix adherent to its anterior wall and at operation also contained sixteen inches of strangulated small intestine. Its probable origin is the result of interruption of fusion between the ascending mesocolon and the posterior parietal peritoneum in the last stage of embryonic rotation of the mid-gut.

It is suggested that the larger retroperitoneal herniæ of this region may have been previously wrongly ascribed to the ileo-appendicular fossa whilst actually occurring into the one described.

I wish to thank Mr. H. S. Souttar, into whose ward the case was admitted, for permission to publish it, and Mr. George E. Waugh for kind advice.

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# LATENT GAS GANGRENE INFECTION.

By A. M. HENDRY,

SENIOR MEDICAL OFFICER, HIGHBURY HOSPITAL, BIRMINGHAM.

THE following cases are considered worthy of record, not only in view of their rarity, but also because of the prolonged and interesting histories, with peculiar clinical findings, and the ultimate onset of acute gas gangrene many years after the receipt of the original wound. All the patients were wounded soldiers, and the histories have been obtained from their medical record cards.

*Case* 1.—F. E. C., admitted on June 13, 1926, sustained a shrapnel wound of the right tarsus in September, 1917. The metal was removed and the wound cleaned by operation, but a sinus persisted. Operations in April and October, 1918, for the removal of necrosed bone failed to promote healing, and in May, 1919, a Syme's amputation was performed. The wound, after healing by first intention, broke down, and this ulceration healed and recurred so persistently that the wearing of an artificial limb was impossible. In March, 1920, the limb was amputated below the knee. From that time the patient had continual pains in the 'phantom' limb, with occasional cramp-like pains in the thigh. To relieve the pains he had had four operations for the removal of neuromata and shortening of nerves in the stump, and on each occasion, after apparently healing by first intention, the wounds broke down in part, and although there was very little discharge they took one to two months to heal. From 1921 an artificial limb had been worn at intervals with discomfort; on two occasions ulceration over the head of the fibula occurred, probably owing to pressure by the artificial limb.

ON ADMISSION.—The patient complained of pains referred to the ankle, with sensation of clawing of the toes, and occasional cramp-like pains in the thigh. He had not worn an artificial limb for four months.

ON EXAMINATION.—The right leg had been amputated below the knee—stump 7½ in.; amputation and other operation scars were well healed, painless, and not adherent; the head of the fibula was very prominent, and a small scar on the outer side showed evidence of recent ulceration. A definite tender neuroma of the internal saphenous nerve was present about four inches below the knee-joint, and one on the external popliteal nerve behind the tendon of the biceps. Although he complained of pains in the thigh, he could not point to a definite site, nor was there any single tender spot. The groin glands were not enlarged. Clinically and radiographically the spine and pelvis, the sacro-iliac, hip-, and knee-joints were normal, and there was no evidence of any bone disease in the thigh or stump. The central nervous system was normal, the Wassermann reaction negative, and the urine free from albumin and sugar.

Operation (Sept. 1, 1926).—After allowing complete subsidence of inflammation over the head of the fibula, operation was performed, the prominent part of the head of the fibula being chiselled away; the neuroma on the internal saphenous nerve was removed and the nerve avulsed. The external and internal popliteal nerves were dissected up to their separation from the great sciatic about four inches above the knee, and divided. All wounds healed by first intention.

Subsequent History.—Three weeks later the patient again complained of pains in the popliteal space and also referred to the foot. On commencing to wear an artificial limb considerable swelling occurred in the popliteal space, or more particularly that area between the upper limit of the bucket and the lower margin of the thigh corset of the artificial limb. This swelling was peculiar; there was no inflammation or tenderness, it was not brawny, nor did it pit like an ordinary œdema. The sensation was rather like that of palpating the fairly well distended bladder of a football. It occurred after wearing a limb about half an hour, and persisted till the artificial limb was left off, when it gradually dispersed.

On Nov. 9, 1926, that is, about two months after the operation, the wound in the popliteal space broke down, and although there was no discharge the sinus persisted for about two weeks.

Second Operation (Dec. 4, 1926).—In view of the persistence of the pain, a further operation was performed. The scar in the popliteal space was excised, but apart from a few thrombotic veins, which were removed, nothing to account for the pain could be found. This wound healed by first intention, but, as on the previous occasion, pain and swelling again recurred on commencing to wear the artificial limb. A period of complete rest for four weeks was given, but without producing any alteration in the condition. Amputation above the knee was therefore advised, and the operation performed on March 5, 1927, the limb being amputated at mid-thigh. At the operation the muscles in the posterior flap were noticed to be of a peculiar blue-grey colour.

Apart from slight pain in the stump, the patient was quite well for two days, and on the morning of March 7 the stump was examined, appeared to be satisfactory, and there being practically no discharge the drainage tube was removed. In the evening, however, the patient complained of increasing pain in the stump and also in the right iliac fossa. The temperature was 99·2° and the pulse 106. Examination of the stump showed it to be swollen and discoloured, and definite crackling was present which also extended to the abdominal wall over the right lower quadrant. The stump was opened up and much gas escaped. Free incisions were made into the crackling areas in the abdominal wall, but the patient's condition rapidly deteriorated, a typical text-book description of gas gangrene ensuing. He died at 3 a.m. on March 8.

A complete section of the tissues of the thigh, from skin to bone, was removed immediately after death and sent for examination.

Pathological Report.—"The sections show thickening and narrowing of arterial vessels with fibrotic change marked in the middle coat—in one vessel a very early organizing thrombosis can be seen. A large nerve-trunk

shows a marked intra- and interstitial destruction of many nerve-fibres. Muscle shows no change therein at certain areas, while at others there are varying degrees of degeneration to complete loss of histological structure. A separation of tissue elements at such degenerated areas with what are probably gas bubbles is also seen. This condition seen in the muscle is due to the proliferation and extension of a Gram-positive short and medium length bacillus in which spores are not seen—later proved to be *B. aerogenes capsulatus*.

"Cultures show the presence of two Gram-positive bacilli that produce spores: (1) A strict anaerobe *B. aerogenes capsulatus*, (2) *B. mycoides*, which grows aerobically and anaerobically. Whether the latter was present within the tissues is not certain."

*Case* 2.—A. H. J., admitted on July 8, 1927, received a gunshot wound of the right arm in September, 1917. Two days later operation was performed for excision of the wound and removal of metal. Ever since he was wounded the patient had had pains in the arm of a vague cramp-like character. In 1920 he had a sudden onset of diffuse swelling of the arm which was diagnosed as an internal hæmorrhage. Since that time he had had many similar attacks, the extent of the swelling varying, and frequently being produced by only a slight flexion of the elbow. The condition had been diagnosed as myositis ossificans, and the patient was given a leather support encasing the whole arm from the shoulder to wrist and fixing the elbow. He had had the following operations:—

1923.—Large spur of bone removed from the humerus; the muscle tissue was fibrotic; microscopic examination confirmed this and also calcareous deposits.

August, 1926.—Medulla of the humerus opened; no pus found.

April, 1927.—Vessels in the arm explored; found normal; periostitis present.

June, 1927.—Two spurs of bone projecting into the triceps removed.

Having just left hospital in Leeds after this last operation, the patient was travelling by train to London, when the arm suddenly commenced to swell. He left the train at Birmingham and was admitted to the Highbury Hospital. He complained of severe pain in the upper arm, and numbness and tingling of the hand and fingers.

On Examination.—There was diffuse swelling of the right upper arm, extending a short way below the elbow; general tenderness, but no single maximum point. There was no discoloration suggesting hæmorrhage, and the swelling did not pit as an ordinary œdema. Wrist, finger, and shoulder movements were complete. Temperature 99·2°, pulse 88. Nothing abnormal was discovered in the heart or lungs; the blood-pressure was—systolic 138, diastolic 78; coagulation time, normal. The central nervous system was normal; Wassermann reaction negative. X rays showed thickening of the middle third of the humerus with some rarefaction and slight periosteal irregularity on the anterior surface, with two small opaque nodules in the area of the biceps, suggesting calcified or bony spicules.

Subsequent History.—The arm was slung up vertically and a firm

bandage applied. The swelling gradually subsided, and at the end of a week the arm was practically normal; no discoloration suggesting hæmorrhage occurred.

Operation (July 20, 1927).—The humerus was exposed by incisions on the outer and inner aspects. All bony irregularities were removed from the shaft, restoring its normal cylindrical shape. An opening was trephined into the medullary cavity at the site of rarefaction suggested on X-ray examination, but no pus or granulation tissue was found. The biceps muscle appeared fibrotic, particularly in its upper outer aspect, and the anterior three-quarters of the muscle was removed. The brachial artery was examined and found to be occluded in its lower half. Small drains were provided in each wound. The removed portion of the biceps muscle was sent for examination.

Next day the patient's condition was satisfactory, the temperature 99·8° and the pulse 88. Some swelling of the forearm and hand was present, and the circulation was rather sluggish. The following day the patient's condition remained the same; there was considerable discharge of a dark grumous material from both wounds.

On July 23 the patient's condition was deteriorating, the temperature being 100·2° and the pulse 100. There was diffuse swelling of the limb, the skin of the upper arm was discoloured, and there was a profuse discharge of gas bubbles with grumous material from the wounds.

Second Operation (July 23, 1927).—Under gas and oxygen anæsthesia the arm was disarticulated at the shoulder and the incision continued to the lateral wall of the chest through the crepitant area, and carried through the serratus magnus and latissimus dorsi muscles, which were of a dark grey colour in part. The deeper muscles of the chest wall appeared normal. The extensive wound was left open and packed with gauze soaked in saturated solution of magnesium sulphate. A section of the tissues from the arm was sent for examination.

The patient was given 40 c.c. of anti-gas-gangrene serum and salines intravenously. Further injections of 40 c.c. of anti-gas-gangrene serum were given on the subsequent two days and 20 c.c. on each of the next two days. The patient developed a septic parotitis which required drainage, and his convalescence was protracted. The wound very gradually cleaned up and healed. The patient was discharged on Oct. 7.

Pathological Reports.—Muscle removed on July 20:—

"One part of the surface was dark, and on section showed recent and some old hæmorrhage, with small proliferation of fibrous tissue and congestion of small vessels. The deeper section showed a slight tendency of intramuscular connective tissue to proliferate and rare foci of infiltration of small round cells at sites of vessels. Three nerves at the more superficial part showed marked interstitial neuritis, most fibres being replaced by fibrous tissue. At the piece of hæmorrhagic surface two or three Gram-positive rods were noted."

Muscle removed on July 23:—

"Tissue consists entirely of muscle tissue in which numerous areas of necrosis are seen. In and around these areas of degeneration there is a heavy infection with bacilli that are most probably of the gas-gangrene group."

The following two cases are also considered worthy of inclusion in this report because of their clinical resemblance to the foregoing cases, suggesting a similar condition, although it was not definitely established.

*Case* 3.—W. H. S., admitted on April 13, 1928, received a gunshot wound of the right thigh in 1916, with injury to the great sciatic nerve. This had been sutured, a portion of the fascia lata removed from the outer side of the thigh being sutured round the nerve. An excellent recovery of the nerve had taken place, but the patient had always had aching pains in the thigh, with attacks of swelling, the thigh feeling at times ' as if it would burst '. In 1921 a small localized swelling had appeared on the outer side of the thigh, and this had gradually increased. He was admitted because of this and on account of his pains, which were increasing in frequency and severity.

On Examination.—The patient had an extensive scar down the back of the thigh, adherent to the underlying muscle. A large muscle hernia was present on the outer side of the thigh where the fascial strip had been removed. Just above the muscle hernia a sensation as of gas crepitus was present. Clinically and radiographically there was no evidence of any bone disease, nor of arthritis of the hip- or sacro-iliac joints. He had no paresis or sensory defect; reflexes were normal and the Wassermann reaction negative. X rays did not show the presence of gas bubbles in the tissues.

Operation (April 18, 1928).—Operation was performed to cure the muscle hernia. This was done by enfolding the muscle upon itself, the fascia being overlapped over this.

Subsequent History.—Three days after operation the patient complained of increased pain in the thigh. On examination of the wound small bubbles of gas were observed issuing from it. He was given 40 c.c. of anti-gas-gangrene serum. The wound oozed for a short time, but it was quite healed in three weeks. The patient was seen six months later. There was no recurrence of the hernia, but the pains and sensation of fullness of the thigh persisted. In view of this he was re-admitted and on Oct. 3 the sciatic nerve was explored. It was found bound down by fibrous tissue, which was removed and the nerve stretched. Prior to this operation the patient was given 10 c.c. of anti-gas-gangrene serum after desensitization. The wound healed without trouble. This operation relieved the pains in part, although he still had attacks at times, accompanied by a sensation of fullness of the thigh.

*Case* 4.—J. H. J., admitted on Feb. 4, 1929, had received a gunshot wound of both buttocks in 1917. The wounds discharged for a considerable time, finally healing in March, 1918. Since then he had always had aching pains in the buttocks, chiefly the left, which at times became swollen and felt ' tight '. In 1923 he had a more severe attack of pain and the buttock became swollen; the wound broke down, but practically no discharge occurred. The ulcer took five months to heal. Two months prior to admission a similar attack commenced, and the wound broke down two weeks later.

On Examination.—An extensive transverse scar was present on each buttock, just above the gluteal fold. There was considerable loss of tissue of the left buttock, the scar in which was dense and depressed, and had in its

centre a deep ulcer from which there was practically no discharge. A probe could be passed forwards one inch. Slight tenderness was present just above and behind the left great trochanter, and the impression given here was as of palpating a sponge. Clinically and radiographically the spine, hip-, and sacro-iliac joints were normal. Rectal examination was negative and the Wassermann reaction negative. X rays showed an absence of any foreign body in this buttock; a small superficial foreign body was present in the right buttock.

The patient was given 10 c.c. of anti-gas-gangrene serum. The swelling soon subsided and the ulcer gradually healed; at no time did any discharge occur.

## COMMENTS.

The outstanding features in the foregoing cases are the long history of vague cramp-like pains without definite localization; the periodic swellings of peculiar type; the repeated breaking-down of scars with prolonged ulceration without discharge; the previous operations without gross untoward consequences; and in *Cases* 1 and 2 the onset of acute gas gangrene almost ten years after the initial wound.

At no time in any of the cases did X rays show gas bubbles present in the tissues; this is of interest, because in several other cases where such bubbles have been shown, operation in the affected area was not followed by any untoward results.

The explanation suggested is that a nidus of organisms of low virulence existed in the muscles of the part. The activity of these organisms being mild, small portions only of a muscle would be irritated, and this unequal contraction might account for the cramp-like pains complained of, any gas produced being of such small quantity that it was readily absorbed. When the focus became stimulated, as by excessive use of the part, or external irritation, or by the laceration of tissues in its neighbourhood by operation, or, as in *Case* 2, by the bony or calcareous spicules, the activity would be greater, and the tension of the collecting gas might become sufficient to cause any weak scar to give way; this ulceration would persist till the activity subsided. The onset of the acute gangrene in the first two cases would follow upon the production of an optimum medium for the organisms by the much greater destruction of muscle, especially if the actual nidus had been cut through, as, from the pathological reports, would appear to have happened in *Case* 2.

I am indebted to Mr. Naughton Dunn for permission to publish these cases, and to Dr. W. A. Broughton-Allcock for the pathological reports.

# PERI-ARTERIAL SYMPATHECTOMY:

## AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF THIS OPERATION UPON LOCAL CIRCULATION.

By LAMBERT ROGERS,

FIRST ASSISTANT IN THE SURGICAL UNIT OF THE WELSH NATIONAL SCHOOL OF MEDICINE, CARDIFF;

AND A. HEMINGWAY,

LECTURER IN PHYSIOLOGY IN THE WELSH NATIONAL SCHOOL OF MEDICINE, CARDIFF.

ALTHOUGH Leriche and his pupils have done much experimental work, at the present time peri-arterial sympathectomy may be described as an empirical operation, since its performance is based almost entirely on the favourable results observed clinically in certain cases to which it has been applied. In some parts of Europe the operation is enthusiastically performed for a great variety of conditions; elsewhere surgeons look upon it with less enthusiasm, while most anatomists and physiologists regard with some astonishment the claims of its most ardent advocates. It therefore appears desirable to attempt to obtain some experimental evidence for or against the procedure. Is the operation merely a surgical fashion of the moment, or has it any underlying scientific basis to justify its performance for conditions in which it is desirable to increase the vascularity of the periphery of the limb? In order to decide this question it is in the first place advisable to consider the usual method of performing the operation on man, because it is obviously necessary to simulate as closely as possible the conditions obtaining in human surgery before drawing deductions from any experimental work on animals.

**The Operation on Man.**—As performed in man, peri-arterial sympathectomy is most often applied to the femoral artery, from which a cuff of adventitia is destroyed, either by peeling it off the vessel,[1, 2] infiltrating it with alcohol,[3] or painting it with phenol.[4] The operation is also performed on the popliteal, the subclavian, and the brachial arteries, and by certain surgeons on the carotids, the abdominal aorta, and the iliac vessels. In but few instances has it been carried out upon more peripheral vessels.

The chief problem presented to us was to see whether we could obtain any experimental evidence of increased peripheral vascularity following performance of the operation upon the femoral, the femoral together with the popliteal, and the carotid arteries of animals.

**Animals Used.**—For the investigation we decided to use cats and albino rabbits. The vasomotor reactions of the cat are easily elicited, and from the experimental standpoint are already known in some detail. Furthermore, the size and structure of their arteries make the operation of peri-arterial sympathectomy technically possible. Albino rabbits were used because changes can be easily observed in the conspicuous vessels of their large pale ears.

**Nature of Experiments.**—Four types of experiment have been attempted:—

1. Following peri-arterial sympathectomy of one femoral artery of the cat, inert dye substances were injected into the peripheral vascular system, and, subsequently, in order to determine the distribution of the dye in the vessels, a post-mortem histological examination of corresponding parts of both hind limbs was carried out. After performing a few of these injection experiments it was decided to abandon them for others better designed to afford information of the vascular system of the limb.

2. Following the work of Hunt,[5] Dale and Richards,[6] and Burn and Dale,[7] certain substances, such as acetyl choline, histamine, and adrenalin, known to act on the arterial and capillary systems, were used to differentiate the responses of normal limbs and those upon which peri-arterial sympathectomy had been performed.

3. The rate of blood-flow through normal limbs and through those upon which the operation had been performed was compared in a further series of experiments by estimating the heat production in each limb by a calorimetric method.

4. The state of the circulation in the ear of the albino rabbit being readily apparent, experiments were carried out to ascertain the effect of the operation when performed upon the arteries supplying the ear.

**The Actions of Acetyl Choline, Histamine, and Adrenalin upon the Blood-vessels of a Limb following Peri-arterial Sympathectomy.**—Heretofore no attempt appears to have been made to ascertain the response to the above substances of a limb upon which peri-arterial sympathectomy has been performed. Hunt has shown that acetyl choline is a powerful dilator of arterioles and capillaries, while Dale and his collaborators have shown that in the cat histamine is a dilator of capillaries and a constrictor of arteries. Acting on the assumption that a vessel already dilated is incapable of giving a dilator response as great as that capable of being elicited from a more constricted vessel, we have used these substances to assess the condition of the circulation.

Changes in the calibre of vessels in the limb have been measured as changes in volume by the plethysmograph, the technique adopted being substantially that described by Dale and Richards. The plethysmographs consisted of glass cylinders, 14 in. long and $2\frac{1}{4}$ in. diameter, open at one end, the other end furnished with two small openings, one of which was used for filling the cylinder with water, the other for connecting it to a small float recorder working on a kymograph (*Fig.* 284). An invaginated rubber cuff made a water-tight joint with the limb. We found it necessary to use very thin rubber for this purpose, since while we required a joint that would not leak we had also to avoid undue pressure on the limb with consequent interference with a free circulation. The animal's fur was thoroughly greased with vaseline to add to the efficiency of the joint. The float recorders were of a small cylindrical pattern and of equal dimensions and leverage. In order to check any mechanical errors due to the recorders the tubes connecting them to the plethysmographs were changed over during the course of certain of the experiments. A hollow needle was tied into a fore-limb vein for the introduction of solutions. Blood-pressure was recorded through a cannula tied into the common carotid artery and connected with a mercury manometer

recording on the kymograph. Anæsthesia was maintained by ether vapour delivered through a cannula fixed in the trachea through an opening in its upper rings.

*The femoral artery in the cat* is easily exposed on the inner (ventral) surface of the thigh in an intermuscular furrow which can be felt extending from the inguinal (Poupart's) ligament along the line of the axis of this part of the thigh. On opening the deep fascia the femoral artery, accompanied by a nerve and a large vein which is usually superficial and overlies the artery, is found embedded in fatty areolar tissue.

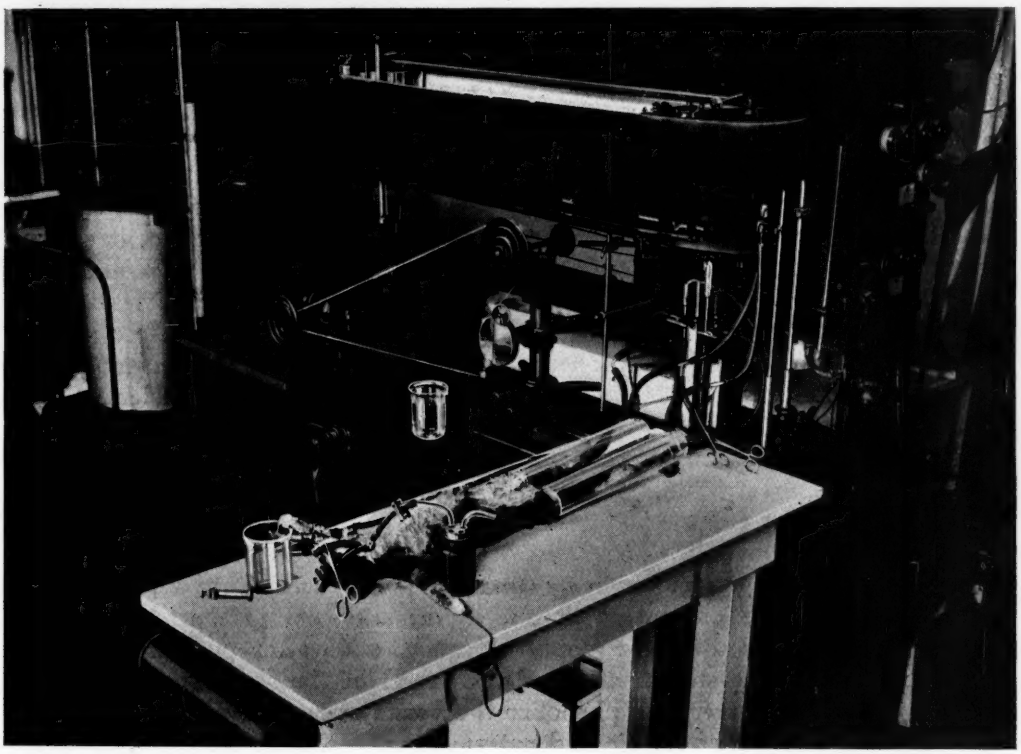

FIG. 284.—Photograph of an actual experiment in course of performance. The apparatus used and the method of obtaining the tracings shown in *Figs.* 285–289 are shown.

**The Operation on the Cat.**—The artery was dissected free, lifted out of its bed, and either carefully stripped of its adventitia for about a centimetre of its length or phenolized by painting it with a fine camel-hair brush dipped in concentrated phenol solution, care being taken not to contaminate the adjacent nerve and vein. In order to avoid this contamination a narrow strip of thin sheet rubber was first placed beneath the artery, and, after well painting the vessel and rolling it first to one side and then to the other so as completely to phenolize its circumference over a length of approximately one centimetre, the vessel was dried carefully with cotton-wool pledgets and replaced in its bed. In some animals the fascia was closed with interrupted catgut sutures, in others there was no separate closure of the fascia. The

skin was sutured with either silkworm gut or catgut, silkworm gut being used in the majority of experiments. In certain experiments one or both femoral arteries were exposed, isolated, and phenolized after the limbs had been placed in the plethysmographs and some preliminary tracings obtained. In these experiments the wounds were protected by saline pads, which were kept moist.

**The Effects of Peri-arterial Sympathectomy on the Artery.**—In human subjects we have noticed, in confirmation of frequently repeated observations of others, that when the artery is healthy, as in young patients, a localized contraction, slightly greater in extent than the length of vessel stripped, takes place at the site of stripping. If, however, the vessel is sclerosed, no change takes place. In the cat we observed a constriction after phenolization in some animals, in others no change was seen, while in still others, in contradistinction to the constriction seen in the human artery, a dilatation was noticed. When this dilatation occurred it did not appear to be due to a mechanical weakening of the vessel wall, as we first suspected, because we observed it following phenolization as well as after mechanically stripping the vessel. In no case of stripping were we able to produce the local contraction seen in the human subject, but it was clearly demonstrated after phenolization.

**The Popliteal Artery.**—We considered that the sympathetic fibres to the vessels might leave the main nerves to the limb at intervals, as these nerves approached the periphery. Woollard[8] has shown that this arrangement exists in the cat, while Blair and Bingham[9] have more recently demonstrated the condition in man.

Because of this arrangement of nerves we extended certain of our experiments, combining stripping or destruction of the network on the femoral artery with similar treatment of the popliteal.

*The popliteal artery in the cat* is deeply placed in the animal's ham and obscured by the large vein which accompanies it and overlies its dorsal aspect. With a little care we found it possible to expose and isolate the artery through a longitudinal incision in the popliteal space, and, after guarding against contamination of the surroundings of the vessel in the same way as in the case of the femoral artery, to phenolize the vessel over a length of nearly five or six millimetres. The sciatic and external popliteal nerves were well away from the site of phenolization and easily avoided when painting the artery.

**The Effects of Peri-arterial Sympathectomy on Local Circulation.**—Immediately following the operation there is no obvious change regularly observable in the general circulation of the limb. We have taken note of the colour of the pads of the paws when these were not pigmented, and have noticed that, although normally of a pale colour, in a few cases following the operation a slight flushing or reddening of the pads occurred, indicating a dilatation of the surface capillaries. The paws of the majority of the animals were too pigmented, however, to permit the use of this method of estimating any change in the circulation, and we have therefore made use of the reactions of acetyl choline, histamine, and adrenalin to measure the degree of vascular dilatation following the operation.

Acetyl choline dilates both arteries and capillaries, and following its introduction into the blood-stream there is a fall in blood-pressure owing to

the diminution of the normal vascular resistance. The dilatation of vessels is measured in the plethysmograph as an increase in limb volume. Blood-pressure is rapidly restored to its normal level, apparently in the first place by the action of the vasomotor centre through the vasoconstrictor nerves increasing the tone of the vessels, and secondly by the excretion of the acetyl choline.

The effect of histamine in the cat is more complex, since there is a double and somewhat paradoxical action, the arteries being constricted but the capillaries dilated. The chief dilatation occurs in the vessels of the skin,

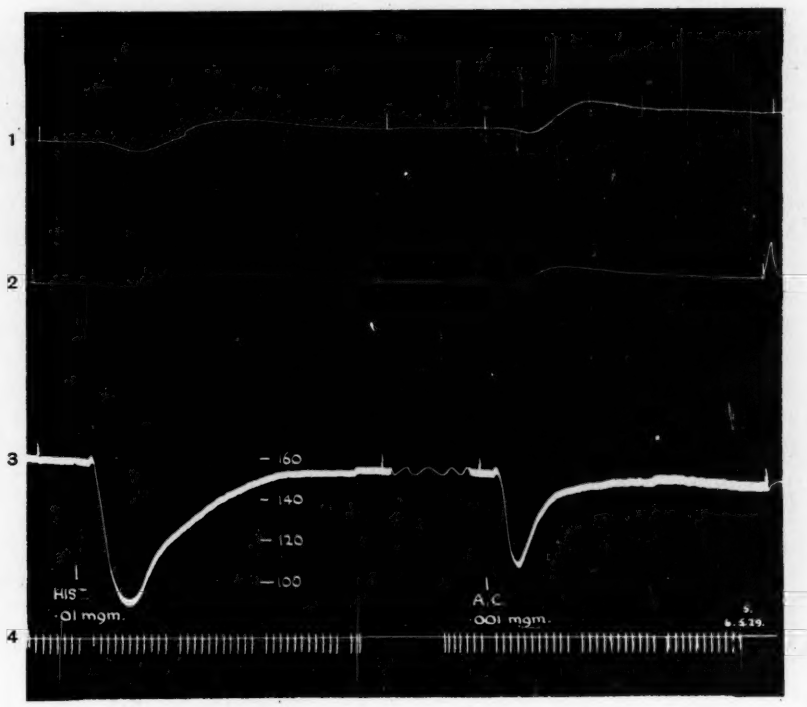


FIG. 285.—Tracings showing limb volume responses and that of the carotid mean blood-pressure to intravenous injection of histamine and acetyl choline. The left femoral artery had been phenolized approximately ten minutes before the record was taken. Reading from above downwards the tracings represent: 1, Right limb volume; 2, Left limb volume; 3, Carotid mean blood-pressure; 4, Time in 5-second intervals.

Owing to vascular dilatation in the limb operated upon there is less response to histamine and acetyl choline in this limb than in the normal limb.

and to demonstrate this opening of vessels as an increase in limb volume, care must be taken to anæsthetize the animal so as to avoid struggling while keeping the anæsthetic fairly light. As little disturbance as possible should be caused to sensory nerve-endings by the various operative procedures. Assuming that these precautions are taken, intravenous injection of histamine is followed by a fall in blood-pressure and an increase in limb volume—the latter evidence of capillary dilatation.

If peri-arterial sympathectomy causes an increased supply of blood to a limb or other portion of the body it can only do so by dilating the vessels

supplying the part. In consequence, the vessels involved will be unable to give their usual responses to acetyl choline and to histamine, since they are already partially dilated. An experiment in which this possibility was investigated is depicted in *Fig.* 285. The tracing shows records of the volume of the two hind limbs. The upper tracing is from the right limb, the lower from the left, and shows the volume changes occurring approximately ten minutes after femoral phenolization. Below these two is the record of arterial blood-pressure, and at the foot of the tracing a time record with intervals of five seconds. Following the injection of 0·01 mgrm. of histamine contained in 1 c.c. of saline, there is a transient fall in mean blood-pressure from 155 mm. Hg to 90 mm. Hg. An increase in limb volume occurs a little later than the onset of the blood-pressure fall, owing to the time period required for the transportation of histamine to the vessels of the hind limbs. It is seen that both limbs dilate, but that a greater response is elicited from the normal limb, indicating that the vessels of the other limb are already partially opened up. A similar differentiation in the response of the two limbs to acetyl choline is shown in the second half of the tracing. Such experiments would indicate that dilatation follows peri-arterial sympathectomy, and further support of this is given by the following experiment :—

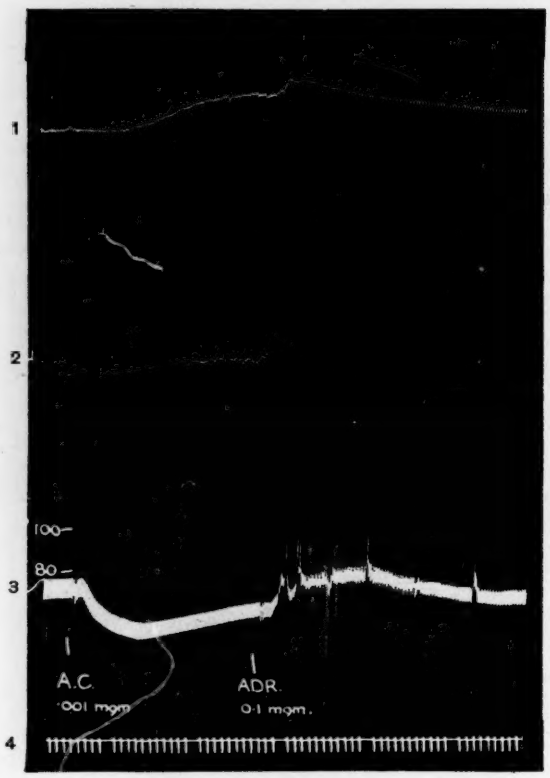


Fig. 286.—Tracings showing limb volume responses and that of the carotid mean blood-pressure to acetyl choline and adrenalin. The right femoral artery had been phenolized approximately five minutes before the record was taken. Reading from above downwards the tracings represent : 1, Left limb volume ; 2, Right limb volume ; 3, Carotid mean blood-pressure ; 4, Time in 5-second intervals.

Owing to vascular dilatation in the limb operated upon there is a smaller response to acetyl choline and a greater to adrenalin than in the normal limb.

Adrenalin in fairly large doses constricts both arteries and capillaries, causing a rise in blood-pressure, quickly compensated by the action of cardiovascular reflexes. Diminution in limb volume gives evidence of the vascular constriction. In the experiment depicted in *Fig.* 286 the altered response to acetyl choline, which we have already described, was first demonstrated, and following that an injection of 0·1 mgrm. of adrenalin was made. The lower of the limb-volume tracings, that from the limb operated upon, shows a greater diminution in volume. This augmented constrictor effect of adrenalin was to be expected if the limb vessels had undergone dilatation

following the destruction of the peri-arterial network, and it therefore confirms the supposition that dilatation had taken place.

Such experiments as these appear to indicate that peri-arterial sympathectomy is undoubtedly followed by an increased blood-supply to the part. Further experiments, however, have convinced us that such dilatation as occurs is but evanescent. In many experiments we have had difficulty in demonstrating the changed response to histamine or acetyl choline, and in others in which differing responses were present at the commencement, these had disappeared before the termination of the experiment. On two

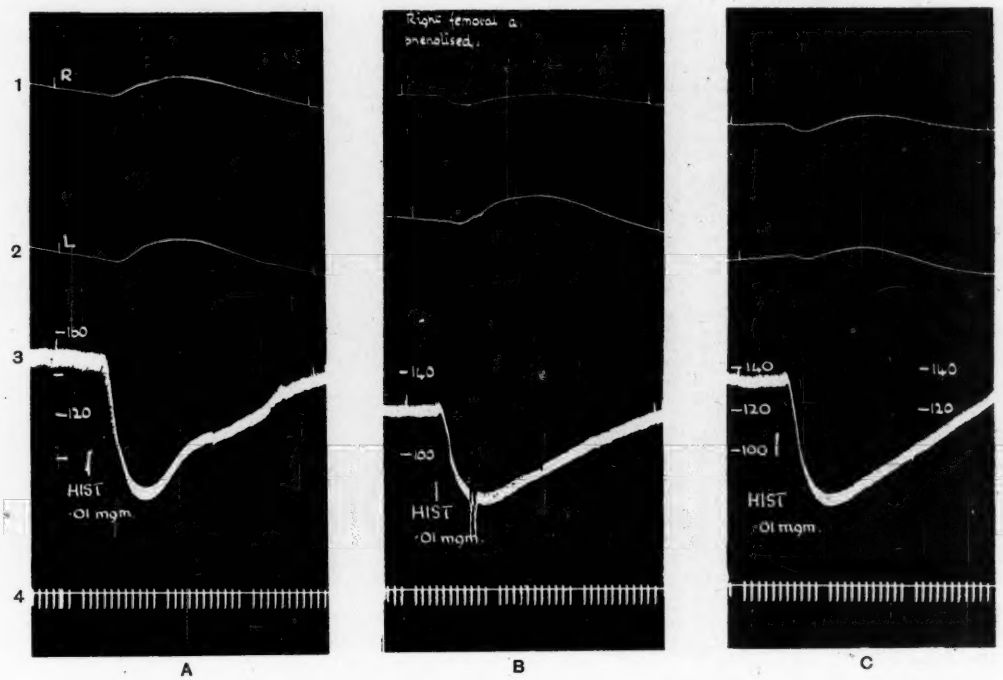


FIG. 287.—Tracings showing limb volume and mean carotid blood-pressure responses to histamine following femoral peri-arterial sympathectomy. In all these records reading from above downwards the tracings represent: 1, Right limb volume; 2, Left limb volume; 3, Carotid mean blood-pressure; 4, Time in 5-second intervals.

A shows the response to histamine when both limbs are normal, B the response *immediately* following phenolization of the right femoral artery (upper tracing), and C the response three minutes after the phenolization. It will be seen that although the histamine dilatation has disappeared in the right limb following immediately upon the phenolization, three minutes later the curves are again parallel as they were at the beginning of the experiment.

occasions, moreover, we have been able to obtain quite definite evidence, showing that the limb-volume changes rapidly disappear. The tracings, A, B, and C in *Fig.* 287 are taken from one of these experiments. Both limbs were placed in plethysmographs and both femoral arteries were exposed and prepared for phenolizing. The reactions to histamine and acetyl choline were then tested and both were found to give a fall in blood-pressure with good limb dilatation. After a brief rest, the right artery was phenolized and the effect of histamine and acetyl choline again measured. The dilatation

previously present in the right limb had disappeared, and there was only a slight preliminary constriction, due in part to a passive following of the reduction in blood-pressure and also to the constricting action of histamine on the arteries. The response to acetyl choline remained practically unchanged. Three minutes were allowed to elapse, and histamine and acetyl choline were again injected. The dilator response to histamine had re-appeared, indicating the regaining of capillary tone.

A similar experiment was then performed upon the left limb. Immediately following the phenolizing of the artery there was a loss

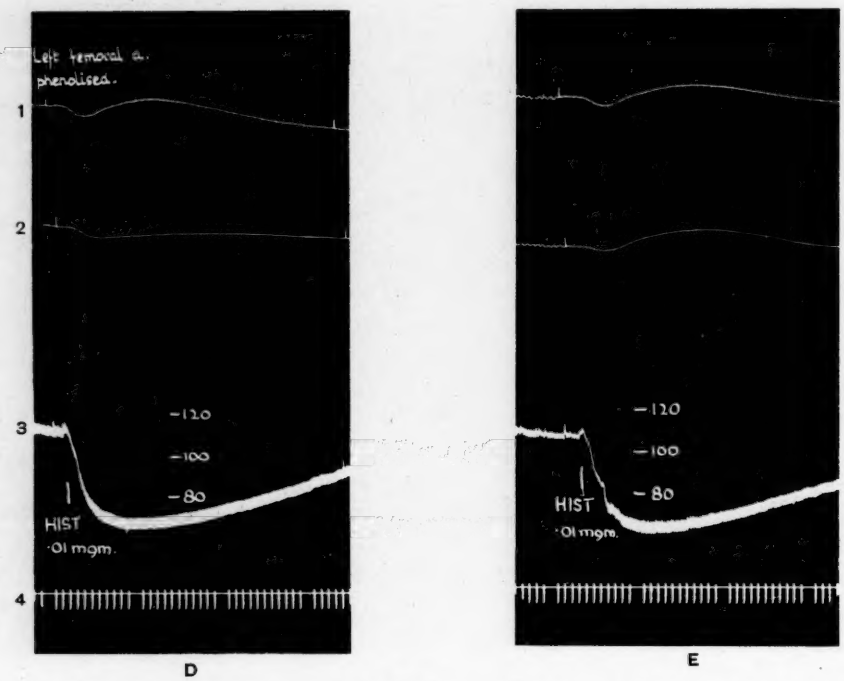


FIG. 288.—The same experiment as in *Fig.* 287. The left artery has now been phenolized. The tracings read from above downwards as in *Fig.* 287. It will be seen in D that the histamine dilatation has disappeared *immediately* following phenolization, but that in E, three minutes later, the curves are again parallel as in A and C (*Fig.* 287).

of capillary tone, shown by the disappearance of the histamine limb dilatation. Within three minutes this was restored (*Fig.* 288, D and E). Finally, as a control, to demonstrate that the actual painting of the arterial wall was not the factor concerned, the right artery was repainted, histamine was again injected, and it was now found that the histamine dilatation had not disappeared.

In the experiments thus far described peri-arterial sympathectomy was confined to the femoral artery. *Fig.* 289 gives an indication of the vascular responses of the hind limb in an experiment where both femoral and popliteal arteries were phenolized. The upper tracing is the left limb which was operated upon. The responses from the two limbs are nearly identical, indicating that any vascular dilatation immediately following the destruction

of the peri-arterial network has disappeared during the thirty minutes which have elapsed since the performance of the operation.

We were therefore led to the conclusion that while in some cases peri-arterial sympathectomy leads to an increased blood-supply, such an increase is only transient.

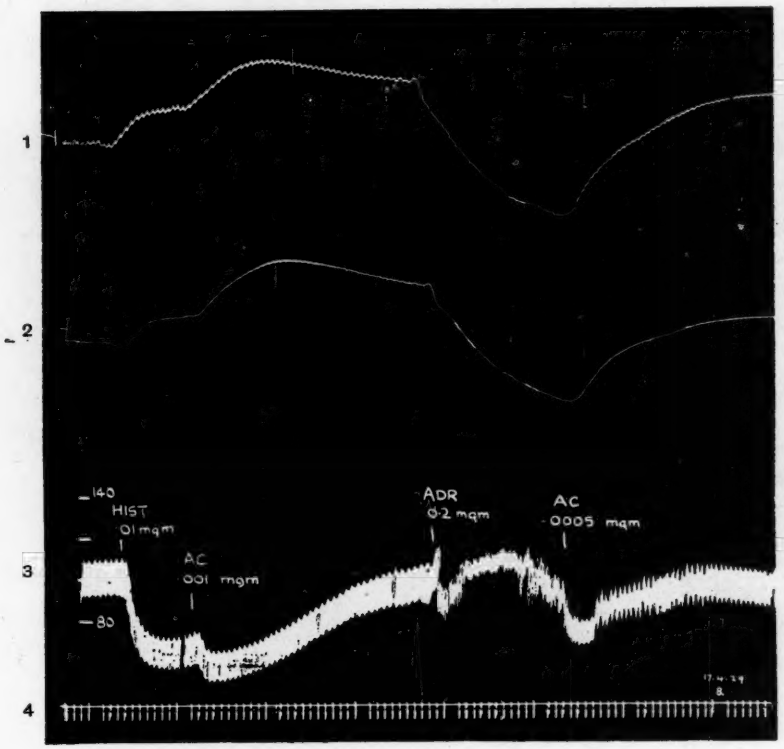


FIG. 289.—Tracings showing limb volume and mean carotid blood-pressure responses to histamine, adrenalin, and acetyl choline. One limb is intact, the other has been subjected to femoral and popliteal sympathectomy performed by phenolizing these arteries. Reading from above downwards the tracings represent: 1, Left limb volume (sympathectomized arteries); 2, Right limb volume; 3, Carotid mean blood-pressure; 4, Time in 5-second intervals.

It will be seen that although the main artery of the right limb has been phenolized in two stages of its course, at the time of the experiment, about thirty minutes following the operation, the responses of the two limbs to vascular constrictor and dilator substances are practically identical.

**Calorimetric Studies following Peri-arterial Sympathectomy.**—Stewart[10] has demonstrated that the rate of blood-flow through a limb may be assessed by measuring its heating capacity by calorimetric methods. Recently Brown and Rowntree[11] in man have measured the heat production of arms and legs following peri-arterial sympathectomy of the brachial and femoral arteries respectively. They report that a fortnight after stripping the artery it was impossible to demonstrate any vasodilatation in the limb.

For measuring heat production we employed two glass cylinders each 14 in. long. These were clamped vertically, and each was closed at the bottom

by a stopper carrying a mechanical stirrer (*Fig.* 290). A thermometer reading to 0·05° C. was introduced into each cylinder through a narrow side tube, junction being made by a small rubber cuff. The anæsthetized animal was held in a sling above the calorimeters so that the hind limbs hung vertically within them. Equal volumes of water, usually 100 c.c. cooled down to 8° C., were poured simultaneously into the cylinders, and increases of temperature recorded at two-minute intervals for twenty minutes. A series of control readings were taken to determine the rate of water heating without the limb.

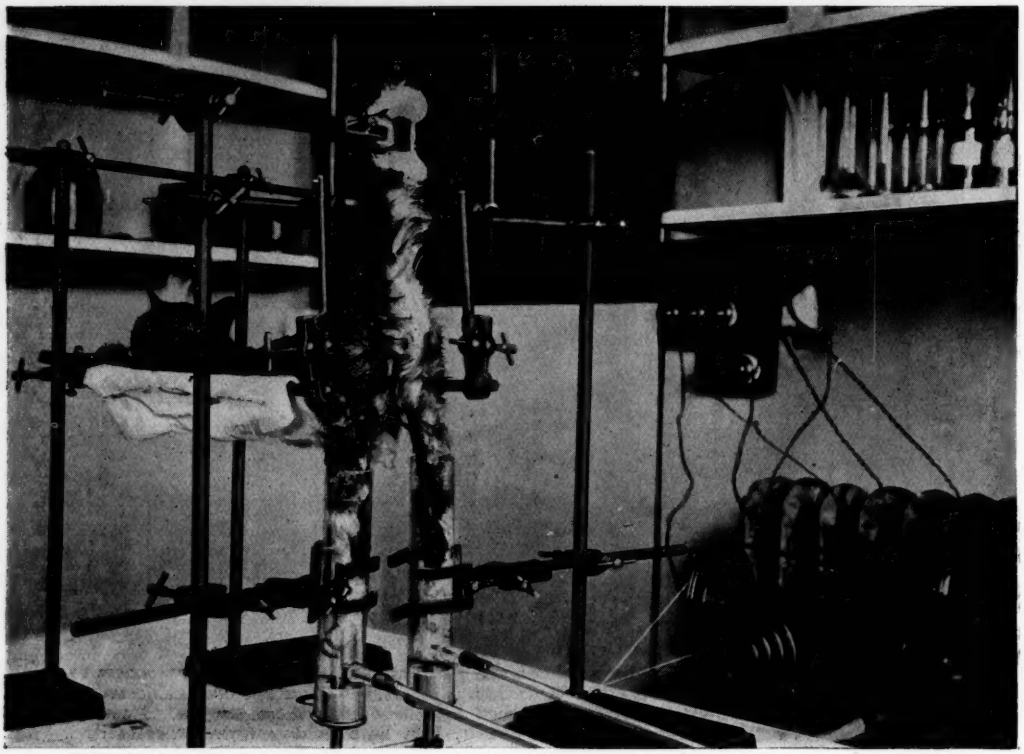

FIG. 290.—Photograph of apparatus used for estimating temperature changes in the limbs following peri-arterial sympathectomy.

Eight cats were examined, and the heat production in the hind limbs was measured at periods varying from a few minutes up to twelve days following the operation. *Figs.* 291 and 292 are tracings from two of these experiments. In no case have we observed any evidence of vasodilatation, the heating capacity of the limb operated upon and of the normal one being identical. In those experiments where the femoral artery was phenolized and the animal permitted to recover, three or four calorimetric records were taken within a fortnight, and afterwards the reactions of the vessels to histamine and acetyl choline were determined as described in the previous section. In four cats which were examined in this manner, the volume responses of the two limbs were identical.

**The Effect of Peri-arterial Sympathectomy of the Common Carotid Artery on the Circulation in the Ear of the Rabbit.**—The original aim of this series of experiments was to isolate the individual arteries supplying the ear

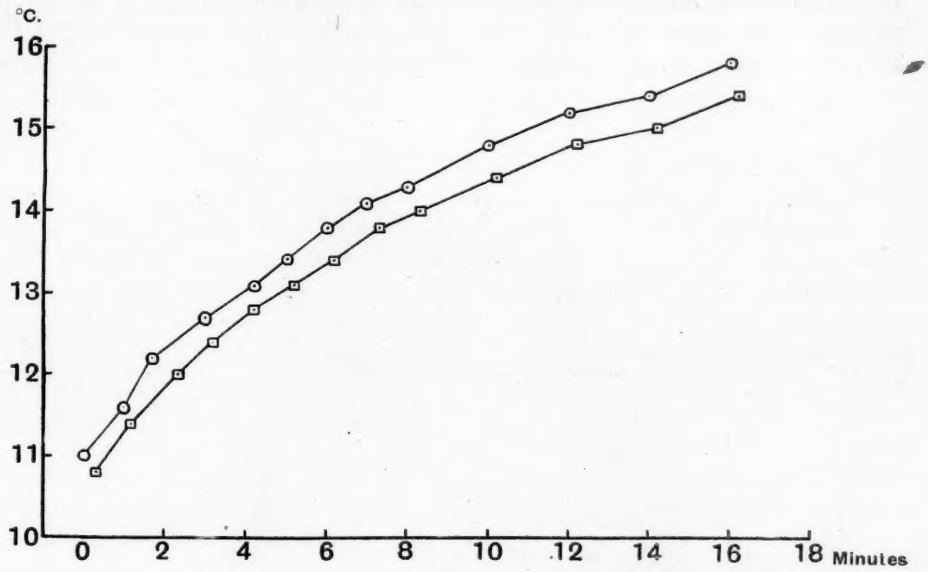


FIG. 291.—Temperature tracings of the hind limbs of a cat subjected to peri-arterial sympathectomy of the right femoral artery six days previously. The lower tracing is from the right limb. Description in text.

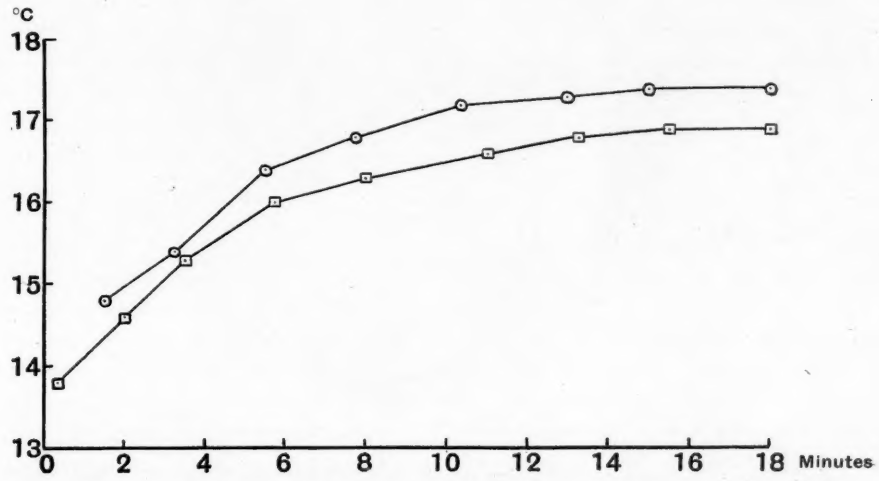


FIG. 292.—Temperature tracings of the hind limbs of a cat subjected to peri-arterial sympathectomy by phenolization of the left femoral artery ten minutes previously. The lower tracing is from the right limb. Description in text. (The left thermometer reads 0·5° C. above the right in all records.)

of the albino rabbit and to destroy the peri-arterial network, but because these arteries are small and technically rather difficult to isolate, we directed our attention, after two abortive experiments on the terminal branches, to

the destruction of the nervous elements situated on the common carotid artery.

The artery was exposed through a mid-line incision extending downwards for about 4 cm. from the level of the thyroid cartilage, the sternomastoid muscle being retracted outwards. The carotid artery was separated from its surrounding structures and isolated upon a thin strip of sheet rubber as pre-

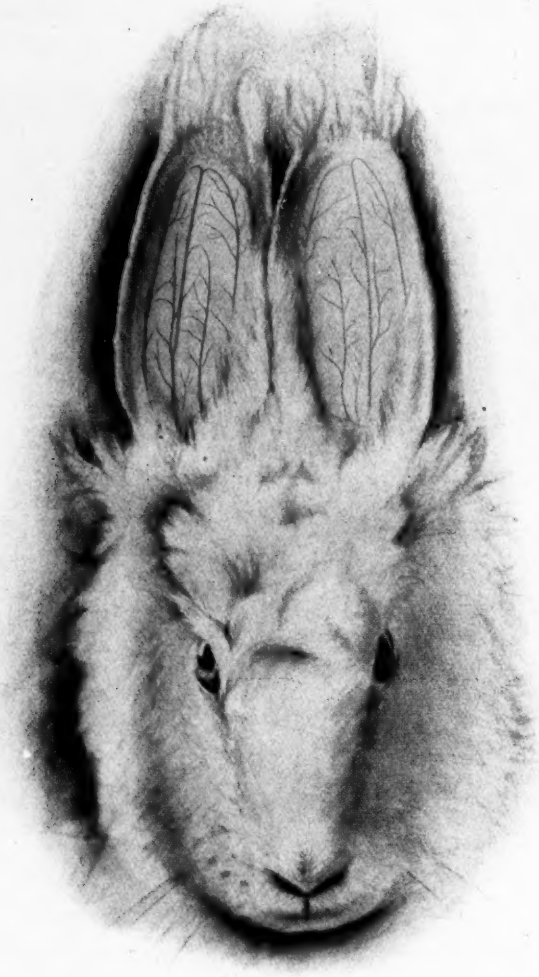

FIG. 293.—Head and ears of albino rabbit six hours after phenolization of the right carotid artery under ether anæsthesia. The vasodilatation in the right ear is apparent.

viously described for the femoral artery. Taking great care to avoid contamination of its surroundings, the artery was painted with phenol, and after drying returned to its original position. The wound was closed with interrupted silkworm-gut sutures.

No immediate change in the vessels of the ear was noticed in four rabbits treated as above, but six hours after the operation in three of these

rabbits the ear of the side which had been operated upon showed well-marked reddening and was warmer to touch than the other ear (*Fig.* 293). This increased vascularity persisted throughout the next day, but in most of the animals had subsided and disappeared by the end of the second. Three weeks after the first operation the other carotid artery was exposed in each case, and following its phenolization a transient vasodilatation was observed in the ear of the same side, similar to that produced in the opposite ear following the first operation.

One rabbit proved an exception. The left carotid artery was exposed and phenolized, but search was also made for the sympathetic trunk. This was found and stimulated electrically, a constriction of the ear vessels during the period of stimulation being obtained. It would appear that some damage was done to the sympathetic trunk, since ten minutes after the observation the left ear vessels were dilated, and continued so for twenty-four days. At the end of this period the right carotid artery was exposed and phenolized, with a result similar to that obtained in the other three animals, the consequent vasodilatation of the ear being only transient. This and other experiments in which the sympathetic trunk was divided have shown how much better and more lasting is the vasodilatation following division of the main sympathetic cord than that produced by denervation of the carotid artery.

It should be mentioned that vascular reactions in the ears of the rabbit appear to be very easily elicited; thus stimulation with the faradic current of the cervical sympathetic, the carotid artery, or even the skin at the base of the ear, causes the vessels to constrict and the ear to become pallid.

**Conclusion.**—Although we have noticed individual variations in the reactions of both sets of animals employed for these experiments, the majority gave the results which are here described, and we therefore conclude that peri-arterial sympathectomy does increase the local circulation, but that its effects are exceedingly transient.

## SUMMARY.

1. An experimental investigation has been carried out of the effects of peri-arterial sympathectomy in animals.

2. A description of the methods employed for the destruction of the peri-arterial nerve network is given.

3. The effect of peri-arterial sympathectomy performed upon the femoral or femoral and popliteal arteries of the cat has been measured by comparison of the responses to certain substances of the vessels of the limb operated upon with those of the corresponding normal limb.

4. Vasodilatation follows the operation, but is very transient.

5. Comparison of the heat production in the limbs of the cat following the performance of the operation on one side, indicates that no permanent vasodilatation results.

6. Peri-arterial sympathectomy performed upon the carotid artery of the albino rabbit results in a vasodilatation of the corresponding ear lasting for about forty-eight hours and then disappearing.

7. Division of the main sympathetic trunk produces a greater and more lasting vasodilatation than peri-arterial sympathectomy of the corresponding main artery.

We are indebted to the Medical Research Council and the Royal Society for defraying the expenses of this research.

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# THE EFFECT OF ABDOMINAL OPERATIONS ON THE MECHANISM OF RESPIRATION:

## WITH SPECIAL REFERENCE TO PULMONARY EMBOLISM AND MASSIVE COLLAPSE OF THE LUNGS.

By D. H. PATEY,

ASSISTANT SURGEON AT THE HAMPSTEAD GENERAL HOSPITAL;
ASSISTANT IN BLAND-SUTTON INSTITUTE, MIDDLESEX HOSPITAL.

It seems well established that operations on the abdomen are definitely more liable than surgical procedures in other parts of the body to be followed by two types of complication: (1) Pulmonary embolism and thrombosis; and (2) Collapse and inflammatory affections of the lung bases.

**Pulmonary Embolism and Thrombosis.**—With regard to these conditions, a considerable amount of evidence exists to show the etiological importance of abdominal operations. For example, Petren[1] (1913) analysed 439 cases of pulmonary embolism from the literature, 83 per cent of which followed abdominal operations; while of his own series of 45 fatal post-operative cases, no fewer than 40 were the sequel of abdominal procedures. Lister[2] (1927), in a very carefully controlled study based on the records of the London Hospital for the years 1909 to 1925 inclusive, was able to bring forward definite statistical proof of the predisposing influence of an abdominal operation. Ducuing[3] (1929) showed that in a large collection of clinical examples of thrombosis the percentage incidence after abdominal operations was much greater than that following operations elsewhere. The present writer was able to obtain figures from 31 of the big London hospitals for the year 1926. Out of a total of 54,253 operations, there were 50 cases of fatal pulmonary embolism, of which no fewer than 43 followed abdominal operations. Again, out of 23 cases of post-operative pulmonary embolism met with in the five years 1923–1926 in the Post-mortem Room of the Middlesex Hospital 20 were abdominal operations. Taking as a sample the total number of operations performed in one year (1926) in the above hospital, it was found that extra-abdominal operations (excluding dental, aural, and ophthalmic) were more frequent than abdominal in the proportion of, approximately, 2 to 1; so that in this series the predisposing influence of the abdominal incision is again well brought out. In the early part of the present century it was thought that lower abdominal and pelvic operations were especially liable, presumably because operations in these regions were the most frequently performed. But with the spread of surgical enterprise to all parts of the abdominal cavity, it gradually became realized that it was not so much an operation in any special part of the abdomen, but abdominal operations generally, which showed this particular predisposition to thrombosis and embolism. Thus, Lister[2] was able to detect no undue frequency following pelvic operations, while the percentage

incidence of the complication in Petren's[1] series was practically identical for operations for myomata of the uterus and for operations on the gall-bladder.

**Collapse and Inflammatory Affections of the Lung Bases.**—The importance of respiratory inhibition as a cause of massive collapse of the lung bases was maintained by Pasteur[4] (1913), who established the clinical signs of the condition on a sound basis. The whole subject of post-operative chest complications has been more recently reviewed by Featherstone[5] (1924), who emphasized their special tendency to follow abdominal operations, adducing as the primary factor responsible the deficient expansion of the lung bases following such operations.

We thus find that most prominent among the theories brought forward to explain the especial liability of abdominal operations to these complications is the suggestion that it depends in some way on an interference with the mechanism of respiration, acting either directly on the lungs or indirectly on the circulation. Such being the case, it seemed to the writer that an investigation of the effects of an abdominal operation on the mechanism of respiration might be of interest. This paper records the results of such an inquiry.

**Clinical Observations.**—It is well recognized that if a patient with a recent abdominal wound takes a series of deep breaths, he will usually complain of pain; this is felt chiefly at the end of inspiration and expiration. The former is probably due to a passive stretching of the wound, while the latter results from the active contraction of the abdominal muscles in expiration. Both types of pain may be relieved to some extent if the abdominal wall is 'splinted' by pressure with the hand or a firmly applied bandage.

**Vital Capacity.**—Though the above facts may be appreciated quite easily on ordinary clinical examination, it is necessary for comparative studies to

*Table I.*—Vital Capacity Before and After Abdominal Operation.

| No. of Case | Sex and Age | Before Operation | After Operation | Operation | + or − |
|---|---|---|---|---|---|
| | | Litres | Litres | | |
| 1 | M., 38 | 2·92 | 1·75 | Tumour of abdominal wall | − |
| 2 | M., 30 | 3·65 | 3·55 | Radical testicle .. .. | − |
| 3 | F., 43 | 1·7 | 1·27 | Cholecystectomy .. .. | − |
| 4 | F., 30 | 2·15 | 0·85 | Salpingectomy .. .. | − |
| 5 | F., 40 | 2·37 | 1·57 | Appendicectomy .. .. | − |
| 6 | F., 33 | 2·3 | 1·5 | Femoral hernia .. .. | − |
| 7 | M., 60 | 2·9 | 1·82 | Cystostomy .. .. | − |

*Table II.*—Controls: Non-abdominal Cases.

| No. of Case | Sex and Age | Before Operation | After Operation | Operation | + or − |
|---|---|---|---|---|---|
| | | Litres | Litres | | |
| 1 | M., 59 | 2·7 | 2·7 | Carcinoma of tonsil .. | I.S.Q. |
| 2 | F., 21 | 2·43 | 2·4 | Dilating and curetting .. | I.S.Q. |
| 3 | F., 27 | 2·35 | 2·35 | Dilating and curetting .. | I.S.Q. |

have some standardized procedure. For this purpose, estimations of the vital capacity may be made. The vital capacity has been defined as the total quantity of air obtained by a maximum expiration following a maximum inspiration. Its amount was measured in a series of cases before and after operation. *Table I* gives the results in seven cases before and after an abdominal operation, while *Table II* shows the readings obtained from three control non-abdominal cases. A glance at the tables will show that, whereas none of the control cases had reduced vital capacities following operation, all the patients with incisions in the abdominal wall showed a diminution, which in most instances was marked. The results are thus in agreement with those of the large series reported by Head,[6] who showed that the fall was most marked after abdominal operations. Similar findings have been reported by other workers.

**Normal Breathing.**—As we have seen above, it is quite easy to show that there is a special tendency to a reduction in the capacity for deep breathing after abdominal operations, and to assess the amount of interference in any given case. But to determine whether the average depth of normal

*Table III.*—Tidal Air Before and After Abdominal Operation.

| No. of Case | Sex and Age | Operation | Tidal Air | | + or − | Comment |
|---|---|---|---|---|---|---|
| | | | Before Operation | After Operation | | |
| 1 | M., 22 | Left inguinal hernia | 312·5 c.c. | 437·5 c.c. | + | Patient unaffected by operation |
| 2 | M., 26 | Exploration of ileum | 365·0 c.c. | 291·0 c.c. | − | Patient ill after operation |
| 3 | F., 26 | Shortening round ligaments | 425·0 c.c. | 280·0 c.c. | − | |
| 4 | M., 45 | Cholecystectomy .. | 285·0 c.c. | 307·0 c.c. | + | General condition good after operation |
| 5 | F., 61 | Hysterectomy .. | 330·0 c.c. | 331·0 c.c. | I.S.Q. | General condition good |
| 6 | F., 40 | Hysterectomy .. | 415·0 c.c. | 317·0 c.c. | − | Rather depressed by operation |
| 7 | F., 63 | Hysterectomy .. | 175·0 c.c. | 219·0 c.c. | + | Feeling rather down after operation |
| 8 | M., 53 | Prostatectomy .. | 613·0 c.c. | 437·0 c.c. | − | Nervous patient |
| 9 | F., 26 | Shortening round ligaments | 285·0 c.c. | 245·0 c.c. | − | Placid individual |
| 10 | M., 30 | Left inguinal hernia | 317·0 c.c. | 217·0 c.c. | − | |
| 11 | F., 60 | Ovarian cyst .. | 326·0 c.c. | 247·0 c.c. | − | |
| 12 | F., 41 | Hysterectomy .. | 111·0 c.c. | 333·0 c.c. | + | ? Leak in pre-operative reading |
| 13 | M., 43 | Chronic appendix .. | 406·0 c.c. | 405·0 c.c. | I.S.Q. | |
| 14 | F., 36 | Chronic appendix .. | 375·0 c.c. | 300·0 c.c. | − | Neurotic vomiting |
| 15 | F., 47 | Hysterectomy .. | 309·0 c.c. | 280·0 c.c. | − | |
| 16 | F., 48 | Ovarian cyst .. | 455·0 c.c. | 354·0 c.c. | − | |

respiration is altered is much more difficult, the approach of any recording apparatus at once tending to affect its rhythm. After trial of several methods it was found best to adopt the technique with a Douglas bag and face-mask as ordinarily used for basal metabolism estimations. The results obtained in a series of abdominal cases before and after operation are shown

in *Table III*, while *Table IV* gives similar readings from a group of control non-abdominal cases. It will be seen that the results are so variable, probably owing to uncontrollable extraneous factors, that it is difficult to come to any definite conclusions. Some cases show a bigger volume of tidal air with an abdominal wound, others a smaller. But if a comparison is made with the control series, one may note that a reduction in the amount of air expired

*Table IV.*—CONTROLS : NON-ABDOMINAL CASES.

| No. of Case | Sex and Age | Operation | Tidal Air: Before Operation | Tidal Air: After Operation | + or − |
|---|---|---|---|---|---|
| 1 | F., 48 | Radium to cervix .. .. | 335 c.c. | 416 c.c. | + |
| 2 | F., 40 | Examination under anæsthetic | 271 c.c. | 290 c.c. | + |
| 3 | M., 41 | Radium into perineum .. | 310 c.c. | 353 c.c. | + |
| 4 | F., 48 | Perineorrhaphy .. .. .. | 372 c.c. | 311 c.c. | − |
| 5 | M., 58 | Excision of carcinoma of anus | 232 c.c. | 307 c.c. | + |
| 6 | F., 48 | Radical carcinoma of breast .. | 260 c.c. | 428 c.c. | + |
| 7 | M., 62 | Amputation of breast .. .. | 406 c.c. | 534 c.c. | + |

with each normal respiration is more commonly met with following abdominal than other types of operation. It seems a fair conclusion, therefore, that, while an abdominal operation has no very constant effect on the depth of a normal respiration, it shows a somewhat greater tendency than operations elsewhere to be associated with a reduction.

**The Movements of the Diaphragm.**—To determine the precise manner in which an abdominal operation interferes with respiration it will now be necessary to go into the question in more detail ; and one may conveniently begin with the chief muscle of inspiration, the diaphragm. The movements of this muscle were studied by means of radiographs taken before and after operation. Since it was found impracticable within a few days of operation to transport patients to the skiagraphical department for screen examinations, the following standard technique was adopted. Before operation two X-ray photographs of the chest and diaphragm were taken with a portable apparatus at the patient's bedside, one at the end of expiration, and the other with the breath held in deep inspiration. Two days after operation similar exposures were made, the patient's bandages being temporarily loosened. On both occasions care was taken to have the position of the patient relative to the X-ray tube the same. All photographs were taken by the same radiographer, using the same apparatus. The technique being thus standardized, the results may be considered comparable. In all, seven cases submitted to abdominal operations were studied, while four cases of radical excision of the breast were used as controls. The breast operation was chosen as a control because, in spite of its proximity to the respiratory apparatus, it is recognized as being rarely followed by thrombotic or embolic complications.

*Results of Investigation of Abdominal Cases.*—In all seven abdominal cases the respiratory excursions of the diaphragm were diminished. In one case (an upper abdominal laparotomy) the diminution of diaphragmatic movement was classified as 'slight'. In three cases (a hysterectomy,

cholecystectomy, and a radical cure of an inguinal hernia) the diminution was classified as 'moderate'. In three cases (a cholecystectomy, a laparotomy, and a pylorectomy) it was classified as 'marked'.

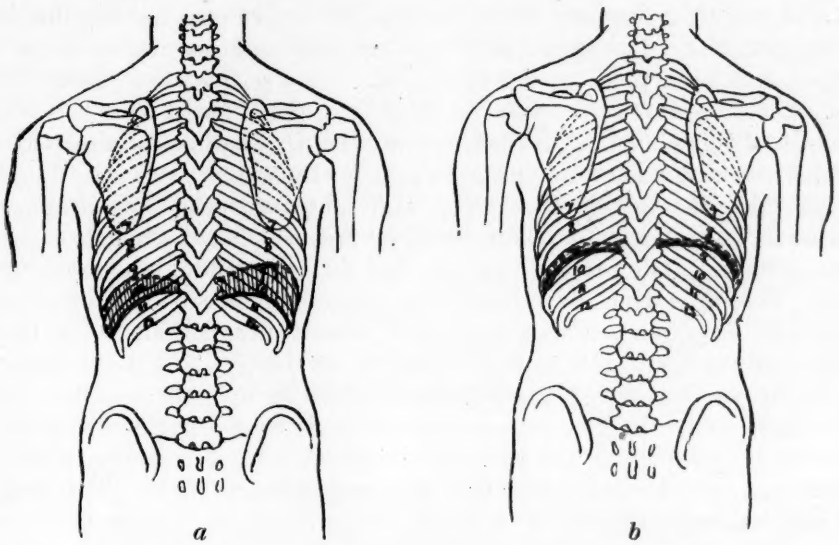


FIG. 294.—'Marked' diminution of diaphragmatic movements after cholecystectomy (as shown in red). *a*, Before operation; *b*, After operation.

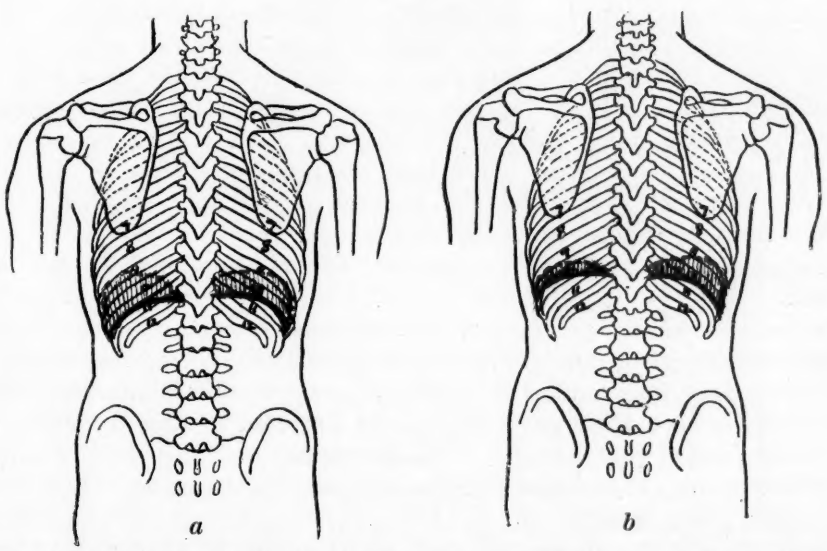


FIG. 295.—'Moderate' diminution of diaphragmatic movements after cholecystectomy. *a*, Before operation; *b*, After operation.

*Figs.* 294 and 295 illustrate typical cases, the former being an example of 'marked', and the latter of 'moderate' diminution. In two cases the diaphragmatic movements, in addition to being diminished, took place about a higher level, owing to pressure from below by distended coils of gut.

*Results of Investigation of Control Cases.*—Of the four cases of radical operation for carcinoma of the breast, three showed as wide a range of diaphragmatic movement after operation as before, while one case showed a diminution which was less than that classified as ' slight ' in the abdominal cases, and may therefore be termed ' very slight '. In one case the diaphragmatic movements on the operated side were not only as extensive as before operation, but took place at a lower level. This patient complained of pain on the affected side of the chest on deep inspiration, and it is possible that as a result of this there was a diminution of costal respiration, and a compensatory increased descent of the diaphragm on that side.

*Suggested Means of Combating the Diaphragmatic Inhibition.*—Many efforts have been made by surgeons to overcome this inhibition of the diaphragm after an abdominal operation, but so far without any uniformity of success. Post-operative deep-breathing exercises, which are often recommended and employed, labour under the disadvantage that, while they will certainly induce a sluggish muscle to move efficiently, they have little effect on a diaphragm which is being seriously inhibited by pain impulses from an abdominal wound. Indeed, one sometimes finds that a patient who clinically appears to be performing the exercises most efficiently, is really, when X-ray examinations are made, using the diaphragm very little. The suggested use of inhalations of $CO_2$ gas as a routine after operation for the same purpose seems open to similar objections. The problem has sometimes been attacked from the other side, and attempts made to diminish the pain in the abdominal wound, which is the cause of the trouble. Novocain and other such local anæsthetics, however, are too transitory in their effects to have any real value in this connection ; while, as to the suggestion that morphia might be useful, the writer found that in the only case in which he studied its action, so far from enabling the diaphragm to descend more efficiently, its use caused this muscle to become more elevated—thus suggesting, if this one case be a criterion, that any beneficial effect that morphia may have on the pain is more than counterbalanced by the general loss of tone resulting from its use. We must therefore conclude that at present the problem of efficient diaphragmatic movement in the presence of an abdominal wound remains unsolved.

**Expiration.**—While the effect of an abdominal operation on the diaphragm has been the subject of much inquiry and speculation, the corresponding effect on the expiratory muscles has excited comparatively little interest. Presumably this is because their particular study presents greater difficulties. We have already noted that patients with abdominal incisions often complain of pain in the wound at the end of a long expiration owing to the contraction of the abdominal muscles involved in this act, but it is not possible to determine directly the degree of such interference. In this study the effect of an abdominal incision on the muscles of expiration was investigated indirectly by a determination of the alveolar $CO_2$, the rationale being the following.

If a patient expires deeply, and the last portion of expired air is trapped and analysed, an estimation of the percentage of $CO_2$ in the alveolar air may be made. If for any reason the patient is unable to expire so deeply, the

sample becomes diluted by the air in the trachea and bronchi, a lower $CO_2$ reading being obtained. Provided, therefore, that one has a pre-operative standard for a given individual, and that care is taken to exclude patients with acidosis and other gross metabolic disturbances, the degree of dilution of the sample of air taken at the end of expiration may be looked upon as a rough index of the amount of interference with the muscles of expiration.

A series of patients before and after an abdominal operation were investigated in conjunction with Mr. H. F. MacLaglan, who analysed the samples in a Haldane's gas apparatus. The specimens were collected by the syringe technique described by Dodds.[7] The following readings were obtained from a typical case—B. C., male, age 30. Operation: left inguinal hernia.

| | Percentage of $CO_2$ in specimens taken. |
|---|---|
| Before operation .. | 6·13 |
| | 5·8 |
| | 6·25 |
| Second day after operation | 5·78 |
| | 5·08 |
| | 4·5 |
| | 4·0 |
| Seventh day after operation | 5·93 |
| | 6·09 |

The two changes that may be noted in the readings on the second day after operation, as compared with the pre-operative, are that the $CO_2$ percentage after operation tends to be rather lower, and that after the first few readings its concentration rapidly diminishes. The reasons for these alterations are quite obvious. The abdominal muscles constitute the chief active expiratory agents, and, being interfered with by an incision, they are unable to express the air from the lungs so completely; with the result that dilution with tidal air takes place, and a lower reading is obtained. The progressive diminution of the post-operative readings may likewise be explained by the greater tendency of the injured musculature to tire.

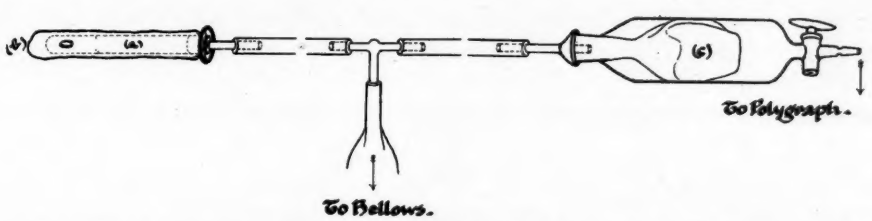


FIG. 296.—Diagram of apparatus used for investigating variations of intra-abdominal pressure. (*a*) is a glass tube with a lateral hole, surrounded by a rubber finger-stall. (*b*) By means of a bellows connected with the apparatus by a T-piece, the finger-stall can be distended after intrarectal introduction. (*c*) is a rubber balloon within a glass chamber, the further end of which is connected with a polygraph recording apparatus.

**The Intra-abdominal Respiratory Variations of Pressure.**—Finally, the effect of an abdominal incision on the respiratory variations of intra-abdominal pressure was considered. The apparatus shown in *Fig.* 296 was used for the investigation. The glass tube was introduced into the rectum, and the finger

stall distended. A curve of the variations of intra-abdominal pressure was obtained by connecting this to a polygraph recording apparatus.

In a normal individual breathing quietly, one finds a slight rise of intra-abdominal pressure with inspiration, and a fall with expiration. On deep breathing the respiratory undulations are similar but more marked. *Fig.* 297

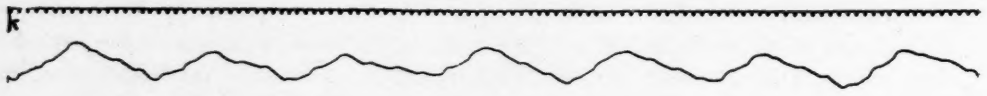

FIG. 297.—Tracing from normal patient showing variations in intra-abdominal pressure corresponding to respiration. The rise was associated with inspiration, the fall with expiration. Note the secondary curves due to the pulse, which in this case are well marked.

shows a typical tracing. In addition to this usual type of curve, one occasionally meets with a second type of curve in normal subjects breathing deeply, a well-marked example of which is illustrated in *Fig.* 298. It will be seen to consist of regularly alternating high curves (*a*), and smaller flatter curves (*b*). The upward stroke of (*a*) corresponded to inspiration, and so

FIG. 298.—Tracing of the intra-abdominal pressure of a normal patient showing a somewhat unusual curve. *a* is the ordinary rise and fall with inspiration and expiration, while *b* is a late expiratory rise due to a forcible contraction of the abdominal muscles after the diaphragm has ceased acting.

far the record resembles the previous one. The secondary (*b*) occurred during the latter part of expiration, and must be due to abdominal muscles of expiration continuing to act after the diaphragm had returned to its normal position, thus causing a further rise of pressure. That the secondary curve is a voluntary act, caused by the forcible expiratory straining, and not a part of ordinary reflex respiration, is shown by the fact that it disappears under anæsthesia (*Fig.* 299). Apart from these two types of normal curve, the only other

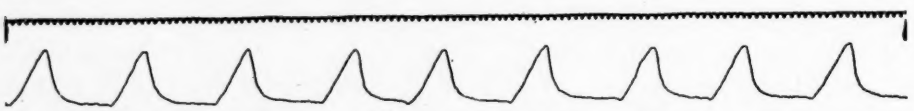

FIG. 299.—Curve of intra-abdominal pressure from same patient as in *Fig.* 298 while under the influence of a general anæsthetic. Shows automatic respiration, with no trace of curve *b*.

point of interest noted in the control subjects was that, in one patient with bronchitis and bronchial spasm, owing to his difficulty with expiration, the curve was reversed, a slight rise occurring with expiration rather than inspiration.

Having obtained a series of normal curves, a number of patients were studied before and after an abdominal operation, to determine the effect

produced by an abdominal incision. Occasionally no marked differences were noted, but as a rule quite definite changes in the curves were seen after operation, which may be summarized as follows: (1) The post-operative curve is less regular; (2) The undulations of quiet respiration are diminished, and the amplification on deep breathing is much lessened as compared with before operation; (3) The secondary curve of late expiration, if present before operation, is either greatly diminished or disappears.

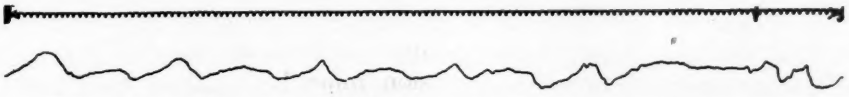

FIG. 300.—Tracing of intra-abdominal pressure of the same patient as in *Figs.* 301, 302. Shows the irregular character of the respiratory variations in intra-abdominal pressure after abdominal operation.

*Fig.* 300 affords a particularly well-marked example of the results of an abdominal operation. A series of control experiments was performed on patients who had been submitted to the operation of radical excision of the breast for carcinoma, but no gross effect was produced thereby.

*The Importance of the Respiratory Variations of Intra-abdominal Pressure.*—The normal variations of intra-abdominal pressure with respiration must be an important mechanism in aiding the return of blood from the inferior vena

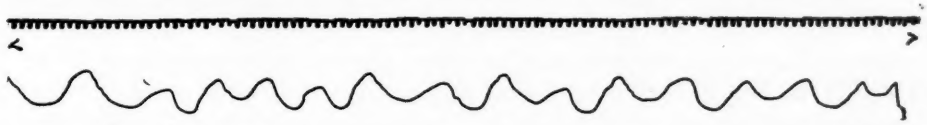

FIG. 301.—Showing artificial rises of intra-abdominal pressure produced by abdominal massage.

caval system of veins to the heart; for the intra-abdominal pressure rises when the intrathoracic pressure is lowered, its positive pressure thus aiding the aspiratory effect of the negative intrathoracic pressure. If, as we have seen, an abdominal incision disorganizes this abdominal pump mechanism, a tendency to stasis in the great veins of the abdomen must result, a condition of affairs which it is always assumed predisposes to thrombus formation. In considering measures to counteract post-operative venous stasis, one may note

FIG. 302.—Showing action of abdominal massage in reinforcing the action of the abdominal pump mechanism if applied during deep inspiration only.

that it is quite easy by massaging the abdomen to produce a rise of intra-abdominal pressure. *Fig.* 301, which is from a patient seven days after the operation of appendicectomy, shows this, each undulation corresponding to a pressure of the hand on the abdomen. In order, however, that such abdominal massage shall reproduce the action of the normal abdominal pump mechanism and play its full part in aiding the venous return, the pressure

should not be applied irregularly, but during inspiration when the intra-thoracic pressure is lowered. *Fig.* 302 shows how, when applied in this manner, the respiratory undulations are reinforced. One may conclude from this that properly applied abdominal massage should be a measure of some value in combating post-operative venous stasis, and might be used to supplement the procedures ordinarily used for this purpose.

**Discussion.**—We have seen that in practically all abdominal cases investigated there must have been a certain deficiency of expansion of the lung bases, and a certain amount of venous stasis after as compared with before operation. In no instance did collapse of the lung or embolic complications occur, and the conclusion must be reached that any effect that respiratory sub-efficiency has in this connection is of a subsidiary or predisposing nature only, and that other factors of an exciting nature are necessary for the development of the complications. As stated early in the paper, this investigation started from the assumption that the reason for the special frequency of the above complications after abdominal operations was a mechanical one. This assumption may be incorrect, and it may be that the special liability of abdominal operations to be followed by pulmonary collapse and embolism depends, not on a mechanical factor, but on something of another nature. It is not proposed, however, to enter into this aspect of the subject here. A question more closely related to the present investigation is whether measures directed to restoring the efficiency of respiration reduce the incidence of these complications. A certain amount of evidence exists to suggest that such measures are of value, but much of the literature on the subject is unsatisfactory and inconclusive. It does seem reasonable, however, since abdominal operations are known to interfere with the efficiency of respiration, to endeavour to combat such interference. In the present state of our knowledge, measures directed to this end cannot be regarded as having a guaranteed prophylactic value, but such an investigation, if rigidly controlled, would constitute a useful piece of clinical research. As a result of this study, one would specially emphasize the importance of combating post-operative distension of the abdomen, owing to its effect on the diaphragm; the value of a firm support in 'splinting' the injured abdominal musculature; and the theoretical considerations in favour of the employment of abdominal massage after operation.

## SUMMARY.

1. It is shown by references to the literature, and by personally collected figures, that thrombosis and embolism, and massive collapse and inflammatory affections of the lung bases, are more liable to be met with after abdominal operations than after surgical procedures in other parts of the body.

2. Acting on the theory that this special liability depends in some way on an interference with respiratory function, a study has been made of the effect of an abdominal operation on the mechanism of respiration.

3. The effect of an abdominal operation on the vital capacity, tidal air, movements of diaphragm, and the respiratory variations of intra-abdominal pressure, is shown.

4. The value of several suggested remedial measures is discussed.

5. It is concluded that any influence that interference with respiration has is of a predisposing nature only, and that other factors are also necessary for the development of the above complications.

I wish to acknowledge my indebtedness to Professor J. MacIntosh, Director of the Bland-Sutton Institute of Pathology, Middlesex Hospital, for granting me facilities for conducting the above investigation, and for his friendly advice. I am also very grateful to Professor E. C. Dodds, Director of the Courtauld Institute of Bio-chemistry, for advising me on several points, and to Dr. F. G. Nicholas, Assistant Radiologist to the Hospital, for his ready help on all radiological questions.

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# *THE RADIUM PROBLEM.*

## II. RADIUM TREATMENT OF BUCCAL CARCINOMA.

By G. E. BIRKETT,

HONORARY RADIOLOGIST, MANCHESTER AND DISTRICT RADIUM INSTITUTE.

In the treatment of malignant disease in any site we are concerned with the primary growth, the immediate lymphatic drainage area, and more distant metastases, generally in the thorax or abdomen, either blood- or lymph-borne. Radium therapy at its present stage cannot pretend to deal with the last type, and although the treatment of the primary growth in buccal carcinoma is on a satisfactory basis, considering the limitations of the method, the problem in the lymphatic drainage area is by no means solved.

Theoretically, metastasis to the lymph-glands in buccal carcinoma may occur by embolism, by permeation, or by both, but at an early stage clinical evidence points to embolism as the method of dissemination. In a large number of recorded cases treated by various methods cures have resulted from the extirpation of the primary growth and secondary deposits as separate entities, no attention having been paid to the intervening lymphatics. If spread had occurred by permeation we should have to assume that the lymphatics had dealt with the contained malignant cells, and I am aware of no histological evidence in support of the theory of permeation. Squamous-celled carcinoma, indeed, in all situations appears to spread by embolism. In such sites as the hand or foot the secondary deposits are in the lymphatic glands, and no nodes develop along the paths of the lymphatics, which one would expect if permeation were the mode of spread.

There is, therefore, justification for dealing with the primary growth and the gland-bearing area as separate entities. The lymphatic glands are the natural means of defence against the spread of the disease in that they act as filters, and it is quite possible that they may be able to deal with malignant emboli just as they do with bacteria. It is therefore reasonable to attempt treatment of the primary growth first of all, and so remove a source both of sepsis and malignant embolism. If, for example, a unilateral block dissection—which by many is considered the best method of dealing with the lymphatic drainage area—is performed prior to the treatment of the primary growth, the lymphatic flow is diverted to the opposite side, and the glands there, which may previously not have been involved, may become so. The performance of a block dissection also interferes with the blood- and lymph-supply of the affected side, and this increases the tendency to radium necrosis. On all grounds, therefore, we feel that the primary growth should first be treated.

**Diagnosis.**—In Manchester it is almost invariably our practice to rely on the clinical evidence in making a diagnosis of buccal carcinoma. Of necessity, particularly before radium became recognized as a valuable therapeutic agent, a large number of the cases which were referred for treatment were recurrences after surgical operations. From a study of these I have been particularly impressed by the injurious effects of incomplete operations in malignant disease, and regard biopsy as such a procedure. The number of cases treated since the present technique was instituted is about 500, and there is ample evidence from a study of the material from the secondary deposits obtained from block dissections to prove the fact that in a large number of cases radium can cure primary growths in the mouth. If a few cases are wrongly diagnosed, they can scarcely, with such a large number, affect the statistical position, and I feel that biopsy is a bad procedure in the interest of the patient. Mr. Geoffrey Keynes tells me that he has discontinued the procedure in treating breast carcinoma, for the reason that recurrence took place in the scar by implantation. Radium treatment is a conservative procedure in the mouth, and the position is quite different from that of the surgeon who proposes to perform a complete or partial glossectomy and who must be sure of his diagnosis.

**Histology.**—Although biopsy has not been practised, the material obtained from block dissections, which often form an integral part in the complete treatment of a case, has always been examined. In general the histological character of the primary growth is reproduced in the secondary deposits, and after a time it was evident that the microscopical characters

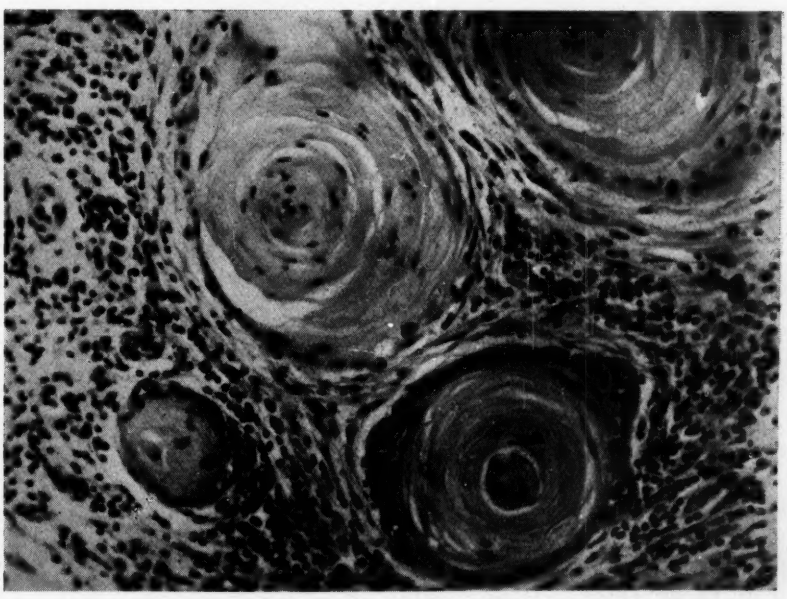


FIG. 303.—Squamous epithelioma of floor of mouth. This is an extreme case of differentiation. Correspondingly metastasis is often late, and in this particular case there was no clinical evidence of metastasis until three years after the primary lesion had been cured.

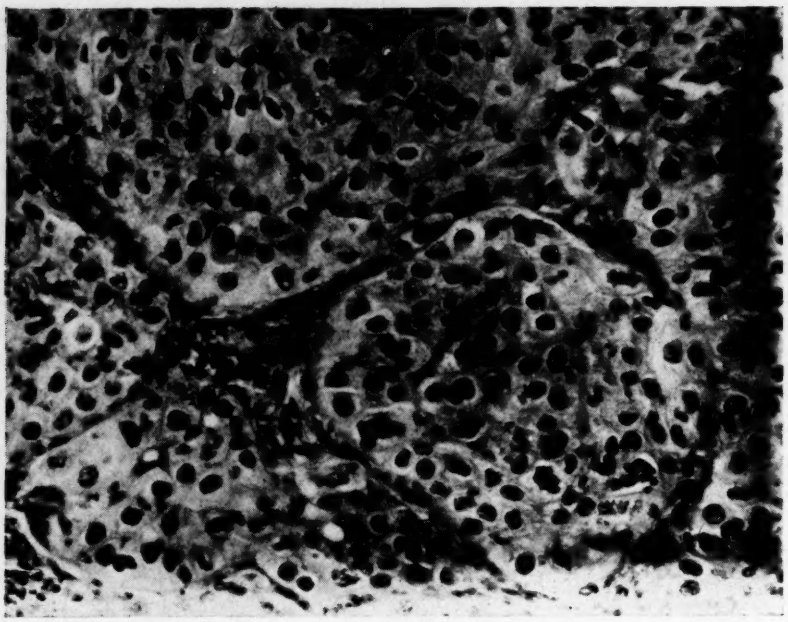


FIG. 304.—Undifferentiated squamous epithelioma. Base of tongue.

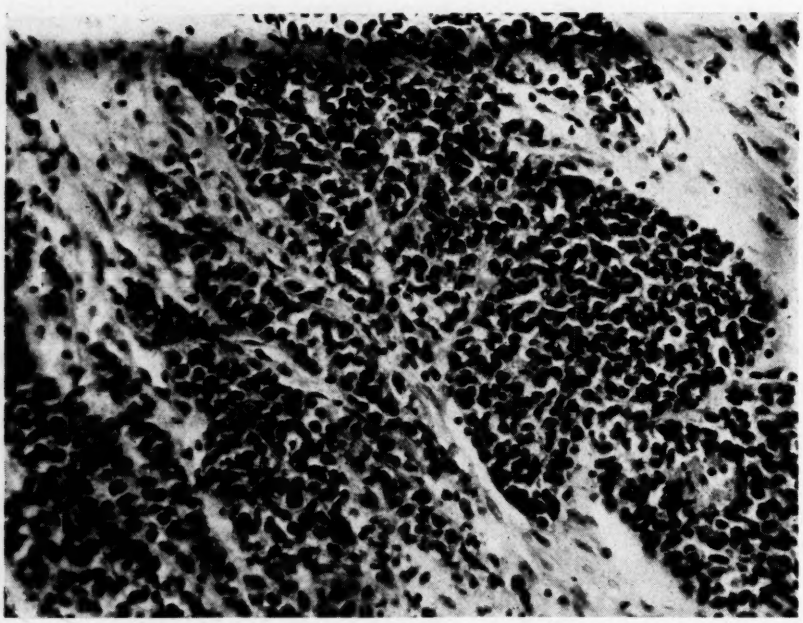


FIG. 305.—An undifferentiated squamous epithelioma of the middle third of the tongue. This resembles the type invariably met with at the base.

exhibited considerable variations. An attempt has been made to correlate these variations with the different sites in the mouth, and the observations from a large number of cases are as follows:—

1. *Buccal Surface of Cheek, Lips, Floor of Mouth, Infralingual Surface of Tongue, Anterior Third of Dorsum of Tongue, Alveoli.*—A highly differentiated type is observed in which cell-nests and keratinization are marked features. Corresponding with this, growth is not so rapid and metastasis is not so early.

2. *Base of Tongue.*—Almost invariably a highly cellular, undifferentiated, squamous epithelioma is observed, which resembles that found in the pharynx and cervix uteri. Cell-nests are rarely, if ever, found. Metastasis is early, and often occurs in the mediastinum, lungs, and even the liver. This type is extremely radio-sensitive.

3. *Middle Third of Tongue, Fauces and Tonsils, Uvula and Soft Palate.*—On the whole an intermediate type is found, in which keratinization is not so marked as in the first class. On the other hand, occasional highly keratinized and also highly cellular types are met with.

Microphotographs (*Figs.* 303-305) are reproduced to show extreme variations. All types respond to radium, but the most brilliant local results are often obtained in advanced cases at the base of the tongue; such results are not procured in the anterior and more accessible parts of the mouth with equally advanced cases.

In an early series of 78 cases the sites of origin in the tongue were investigated: 52 (66 per cent) were in the middle third; 16 (20 per cent) were in the anterior third; 10 (12 per cent) were in the base.

**The Evolution of Radium Treatment in the Primary Site.**—This is an interesting subject, and, just as in nature development proceeded along different lines, by a process of elimination some uniformity of method has resulted. Naturally at first treatment was a process of trial and error, but Dominici first realized the importance of filtration, and the principle of the selective action of the $\gamma$ ray.

Surface application was first tried with comparatively intense sources for short periods of time. If these are not filtered, $\beta$ rays are given full play, but their effect is very localized and differs little from that of the cautery. The law of the inverse square, by which the intensity of the rays, whether $\beta$ or $\gamma$, varies inversely with the square of the distance, also made this an unsuitable method except for very superficial types of growth. It is true that it is theoretically possible to increase the intensity at the surface so as to discount this effect at a depth, but the immediate effect around the source then becomes so intense as to produce necrosis or a burn.

Implantation of needles containing radium salts or emanation followed, and was first tried by Stevenson and Joly, of Dublin. Fairly intensive sources were used, but the principle of filtration so as to use only $\gamma$ rays was not employed. Twelve to twenty-four hours were average exposures.

The war period undoubtedly retarded advances, but gradually the intensity of the implanted sources was cut down, and the time of exposure correspondingly increased. This was the foundation of the modern method of treatment for the primary growth in buccal carcinoma, and is largely due

to the work of Regaud, who combined this principle with the filtration advocated by Dominici. The American School at this period discarded filtration entirely, and implanted small capillary tubes of glass containing emanation, which were left in the growth. Some of these sloughed out, but some remained permanently in the tissues. Owing to the action of the β rays an intense reaction with necrosis and sloughing resulted, and, although many good results were obtained, many patients died from the sepsis, pain, and consequent exhaustion which often occurred. This method, sometimes combined with electro-coagulation, was used at the Manchester and District Radium Institute before the present technique, which was adopted at the end of 1925. An analysis of some 50 cases which were apparently cured for varying periods of from one to nine years showed that this principle of prolonged irradiation was responsible for 80 per cent of these apparent cures. The contrast between the severe reaction of the unscreened method of treatment and the uniformity of result and comparative painlessness of Regaud's method was to me dramatic. The result has been that rarely is a case treated without marked amelioration of symptoms even if a primary cure is not obtained, and this is reflected in the fact that a patient who has been treated seldom fails to attend again for examination when requested to do so.

## TECHNIQUE.

**Needles or Seeds ?**—There is at the present time in this country a difference of opinion as to the advantages in the use respectively of needles and removable platinum radon seeds. In both, the external diameter is cut down to a minimum and the trauma from insertion is on this account negligible, but seeds have a relatively short active length—0·3 mm. is commonly used—whilst needles may vary between 10 and 30 mm. in length. The method of

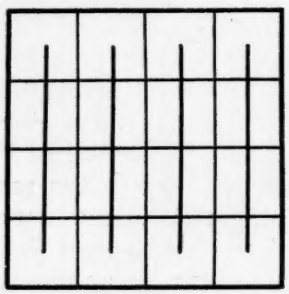


FIG. 306.

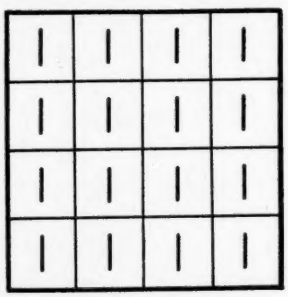


FIG. 307.

implantation, however, depends a great deal upon the skill of the operator, and, when a physical agent is being used which is constant in its action, we feel strongly that any method which tends to eliminate this variable human factor should, as far as possible, be adopted.

If *Figs.* 306, 307 represent a cross-section of an area to be implanted, then it is obviously easier to insert four needles each of active length 12 mm. than 16 seeds of active length 3 mm. As a practical illustration, we have personally used with success 20 needles each of active length 15 mm. in the

treatment of a buccal carcinoma, representing a total active length of 300 mm. We doubt whether the equivalent active length in seeds, which would require 100, could have been adequately spaced. Failure to implant accurately means that some part of the tumour is under-irradiated, leading inevitably to recurrence.

**Filtration.**—Personally we use a minimum filtration of 0·5 mm. of platinum, which allows about 0·4 per cent of β irradiation to pass into the tissues, and a maximum of 0·6 mm. of platinum. Practically all our radium element is put into cells of wall thickness 0·2 mm. of platinum, and these cells are contained in sheath needles of wall thickness 0·4 mm., giving a total filtration of 0·6 mm. The weak point in a needle is the seal between the trocar point and the body, and we consider that the use of cells gives twice as much protection against leakage due to trauma or the accidental contact of mercurial or iodine solutions with the gold seal.

**Dosage.**—It is often stated that a 'dose' of so many milligramme-hours is suitable for a case of buccal carcinoma; but this is a useless expression. If needles are implanted a certain distance apart, then obviously their number and the total amount of radium element or emanation used will vary with the size of the growth. Empirically we know that linear sources containing so much radium element or emanation can be inserted into normal tissues for corresponding time periods without harm, and the optimum relations of time and intensity are also known. The important points then in detailing technique are: (1) The linear intensity or the quantity of radium element or emanation contained per linear centimetre—the diameter of the source is reduced to a minimum and is a constant; (2) The screen or filter; (3) The time of exposure; (4) The number of sources used, and their active length; (5) The position of the sources, and their distance apart.

*Active Length.*—The active length of an implanted source refers to that part of the needle which contains radium salt or its emanation. In buccal carcinoma the most useful active length is 15 mm., but as a variable quantity it can be expressed as being between 10 mm. and 30 mm.

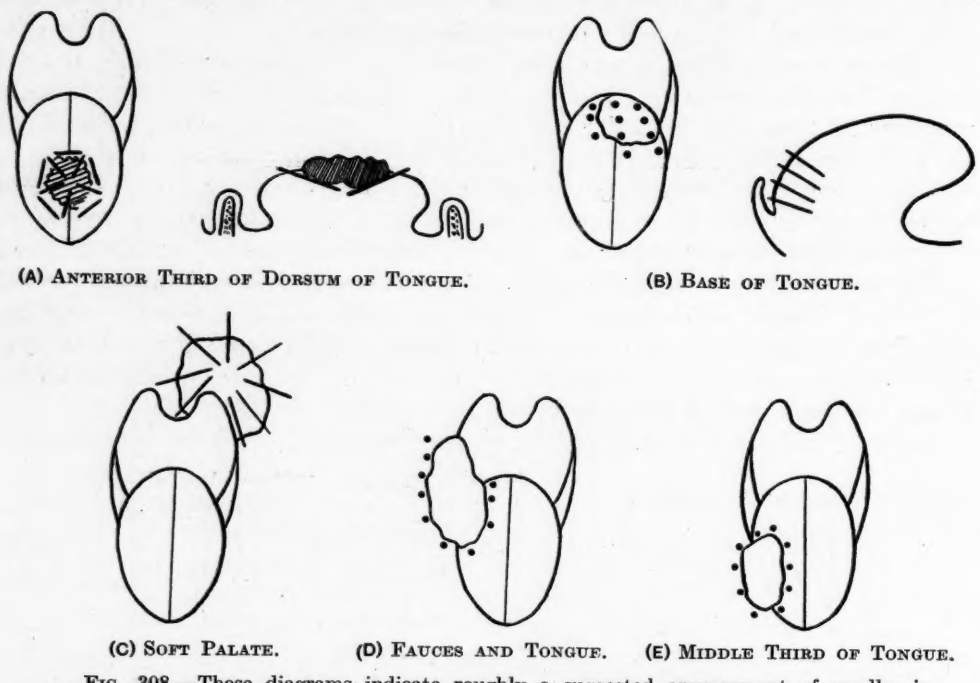
Our technique according to the above considerations is as follows:—

| | | |
|---|---|---|
| 1. | Linear intensity | 0·66 mgrm. radium element<br>1·7 to 2 mc. of emanation |
| 2. | Screen | 0·5 to 0·6 mm. of platinum |
| 3. | Time of exposure | 7 to 12 days |
| 4. | Active length | 10 mm. to 30 mm., but the commonest is 15 mm. |
| 5. | Number of sources | Rarely exceeds twenty |
| | Distance apart | 1 to 2 cm. |

**Anæsthetic.**—A general anæsthetic is given whenever possible, and our preference is for the intratracheal method. Palpation of the growth is essential, and the treatment of growths at the base of the tongue is considerably helped by forcible traction and bimanual palpation. We do not believe that this can be adequately performed under local anæsthesia. Almost invariably we find during the examination under general anæsthesia that the growth—if the tongue is involved, at any rate—is more extensive than the ordinary clinical examination reveals, owing to the intolerance of the patient. This should be remembered in estimating the number of needles.

**Removal of Teeth.**—Most authors stress the importance of removal of septic teeth before radium treatment is given. We cannot agree entirely, and think that it is a definitely bad procedure where the growth lies near or is in contact with the alveolar margin, as frequently happens in lesions which involve the floor of the mouth. Quite often a patient gives a history of a " sore place in the floor of the mouth " followed by a visit to a dentist with extraction of teeth. After this the condition, he says, became definitely worse, and we believe that rapid spread often occurs along the alveolar margin as a result. In cases where a sharp and carious tooth has been the main factor in the production of a carcinoma of the middle third of the tongue the extraction of this is beneficial, but personally I prefer to proceed with treatment rather than that delay should be caused by a widespread removal of teeth.

**Fixation of Needles.**—It is extremely important that needles be securely sutured, as otherwise—except where the base of the tongue is concerned—they will scarcely be retained for the full time period. There are various ways of doing this, and we have found the following method satisfactory.



(A) Anterior Third of Dorsum of Tongue. (B) Base of Tongue.

(C) Soft Palate. (D) Fauces and Tongue. (E) Middle Third of Tongue.

Fig. 308.—These diagrams indicate roughly a suggested arrangement of needles in various sites. As far as possible they are buried in healthy tissue parallel with the infiltrating edge of the lesion. An exception is the base of the tongue (B), where they are systematically implanted at right angles to the surface both in the tumour and in healthy tissue.

In the first place, stout silk thread is threaded through the eyelets of the needles before they are sent up to the theatre. The distal end is knotted, leaving a double length of about eight inches. A knot is then tied close to the eyelet hole, and through this is passed a piece of iodized catgut threaded in a Lane's half-circle palate needle. When the needle has been implanted

it is securely anchored by the catgut suture to healthy tissue if that is possible. As a rule, by the end of seven or eight days the catgut will have become partially absorbed and simple traction suffices to remove the needles. After all the needles have been secured individually the silk threads are gathered together and sutured, about one and a half inches from their attachment to the needles, to some part of the buccal mucosa. The ends are then brought out at the angle of the mouth, and fixed to the cheek with adhesive plaster. Any accidental traction on the silk threads will therefore not be transmitted to the needles.

Wherever it is possible needles are implanted outside and parallel with the infiltrating edge of the lesion, but with a large nodular growth, such as may be found in the tongue, they are also inserted into the lesion itself. They should not be placed close to bone if this can be avoided, as a troublesome necrosis may result; but if bone is invaded, then it is almost impossible to avoid this if a cure is to be obtained.

A few diagrams which illustrate the insertion of needles in various sites are shown in *Fig.* 308, A–E, but it is impossible to lay down any hard and fast rules. Experience and a careful examination of all patients after treatment are the main factors in success.

**Element or Emanation ?**—Personally we have not come to any definite decision with regard to the use of element or emanation. The former gives a constant intensity of irradiation, the latter one which diminishes by one-sixth per day. If a time period of eight days be taken, then, with a linear intensity of 0·66 mgrm. of radium element, the number of milligramme-hours per unit of length is $8 \times 24 \times 0{\cdot}66$, or 127. If the initial linear intensity is 1·8 mc., then that at the end of eight days will be 0·45 mc., and the millicuries destroyed 1·35, a quantity equivalent to 179 milligramme-hours. An initial intensity of 1·3 mc. per linear centimetre is physically equivalent to 0·66 mgrm. of radium element for a period of eight days. In practice, however, we have found 1·8 mc. to be a suitable strength, and there is the possibility that if the intensity should fall below a certain level no effect will be produced on the malignant cells. Russ[1] refers to the experimental proof of this.

We have a distinct impression at the moment that those cases of buccal carcinoma which have developed necrosis have occurred where radium element has been used, but the whole question will have to be analysed more carefully before any definite conclusion can be reached.

**Notes on Technique in Various Sites.**—

TONGUE.—

*Anterior Third of Dorsum.*—It is extremely rare in our experience for an epithelioma to arise here except on a chronic specific glossitis. In such cases the nutrition of the tissues is not normal owing to an endarteritis and lymphangitis obliterans and the scars of healed gummata. The result is that the normal response is interfered with, and in some cases such epitheliomata appear to be definitely radio-resistant. In other cases the lesion may disappear, but an indolent ulcer with sharply cut edges and a depressed base may persist, which takes a considerable time to heal. On the whole we are in favour of a prolongation of the time period to about ten days in these cases, with a screen of 0·6 mm. of platinum. Needles of active length 15 mm.

are suitable. Lymphatic spread is usually late here, probably owing to the tendency to obliteration of the lymphatics by the chronic inflammation of specific origin. (*See Figs.* 308 A.)

*Middle Third.*—These lesions usually start at the border of the tongue just anterior to the faucial pillar, and tend to spread into the substance of the tongue, on to the floor of the mouth, and on to the fauces and tonsil. We generally use needles of active length 15 mm. In the tongue they are inserted at right angles to the surface around the medial border of the lesion, whilst they are pushed horizontally backwards below the growth. If invasion of the fauces has occurred, they are placed horizontally and parallel with one another beneath the base of the ulcer. Sometimes such a growth becomes attached to the ascending ramus of the mandible, and it is then that necrosis of bone is almost inevitable. (*See Figs.* 308 D, E.)

*Base.*—It is almost impossible to suture any but the most anterior of the implanted foci here, and the growths are often so bulky that the needles have to be placed in the substance of the tumour. Luckily these growths are all of an undifferentiated and radio-sensitive type, and accurate implantation, though desirable, is not so necessary to obtain a good local result as in the more anterior part of the tongue. We always try to place equidistantly from 9 to 12 needles of active length 15 mm. in the base of the tongue irrespective of the apparent extent of the lesion. The tongue is drawn well forward, and, with a right-angled introducer, the needles are inserted at right angles to the surface (*see Fig.* 308 B). They have thus a slightly forward inclination, and accidental traction on the silk threads does not tend to displace them, as its direction is at right angles to the axis of insertion. Retention is aided by the relative immobility of this part of the tongue. A time period of 7 to 8 days is usually sufficient.

Soft Palate and Uvula.—We prefer needles to seeds despite the difficulty of burying them, owing to the thinness of the tissues. With care and persistence and good anæsthesia the operation can usually be performed. In addition to the usual type of active length 15 mm., needles of 10 mm. active length will be found useful. (*See Figs.* 308 C.)

Floor of Mouth.—As a rule these lesions are superficial and needles can be inserted beneath their base parallel with the floor of the mouth. Needles of active length 10 and 15 mm. are usually employed.

Cheek.—Implantation is, in our opinion, preferable to surface application, and can sometimes be performed through the external surface of the cheek, in which case the needles are more easily retained. An active length 15 mm. is suitable.

Hard Palate and Alveoli.—It is difficult to implant needles here, and some form of surface application is desirable. If these growths are seen at an early stage they are often superficial and tend to spread along the paths of least resistance, i.e., along the mucosa. A reference to *Fig.* 309 will give some idea of the form of the apparatus. Upper or lower plates are made of vulcanite, and the units of irradiation are contained in a box. Needles or tubes of suitable active length and standard linear intensity (0·66 mgrm.) are placed in the base and fixed about 1 cm. apart between two layers of adhesive plaster, which can be kept in position by packing

the interior of the box with cotton-wool. As the lesions lie close to bone the screen can with advantage be increased to 0·8 mm. of platinum, so as to cut out the $\gamma$ rays of longer wave-length. The 'box' keeps the units of irradiation at a distance from the opposing alveolar margin, and is the best method of protection, remembering the effect of the inverse-square law

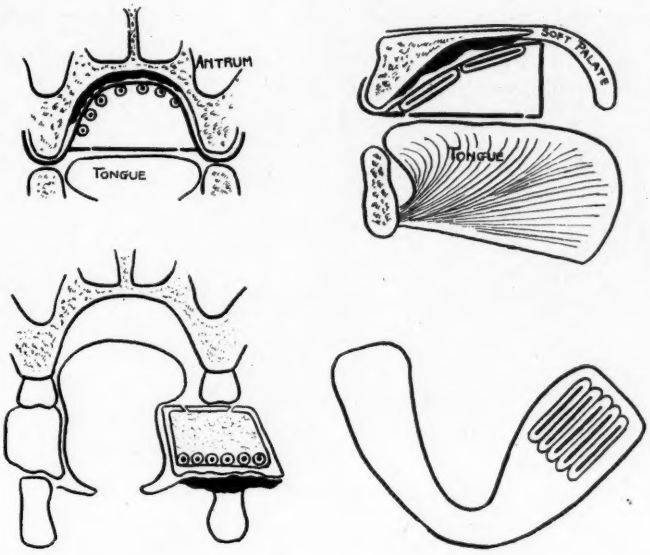



FIG. 309.—Diagrams to illustrate vulcanite plates which contain radium tubes for the treatment of growths involving the hard palate or lower alveolar margin. 0·8 mm. of platinum is used as a screen so as to absorb the $\gamma$ rays of longer wave-length owing to the proximity of bone. In each case the units of irradiation are placed in a box between layers of adhesive plaster, the rest of the cavity being packed with cotton-wool. In the case of the palate this keeps the tongue and, in the lower alveolar margin, the upper alveolus, at a distance from the source of irradiation, and lessens the reaction and tendency to necrosis respectively. The intensity of irradiation varies inversely as the square of the distance.

on the intensity of irradiation. Seven to eight days of irradiation will probably prove ample, and it is a good plan to change the position of the tubes, if this is possible, once or twice during the period. Probably more homogeneous irradiation is thus obtained.

**Re-insertion.**— In all the above situations in which the lesion is very extensive it is better to remove the needles at the end of five days, and re-insert under a general anæsthetic for a similar period of time. Errors of distribution at the first attempt are probably corrected to some extent, and we have found that extensive lesions can be more successfully treated. We regard this as a definite improvement in technique.

**Protection of Bony Structures or Adjacent Soft Tissues.**—It will probably have been noticed that no reference has been made to the wearing of lead plates over the alveoli or hard palate, as advocated by some authors. We have not found it necessary, and think that it puts too great a strain on the tolerance of patients, which must often have reached its limit. After all, 0·6 mm. of platinum absorbs all the $\beta$ irradiation, whilst a mould composed of 1 mm. of lead will only absorb about 4 per cent of the total $\gamma$ irradiation which strikes it.

## AFTER-RESULTS OF TREATMENT OF PRIMARY GROWTHS.

**Normal Reaction.**—In few places can the reaction on a mucous surface be studied so well as in the mouth. By about the tenth day quite an appreciable change will be apparent. If the lesion should be a projecting one it

will have become considerably flattened, and for a variable distance around the lesion of from 1 to 2 cm. the normal mucosa will be covered by an adherent, greenish-yellow, fibrinous deposit, which is perhaps best compared with that on the pleura of the lung of a patient dead of lobar pneumonia. In the case of a nodular lesion the treated area does not look unlike an infarct, and it is curious that the line of demarcation between the reaction zone and the surrounding mucous membrane is very sharply defined. This becomes more

FIG. 310.—An infralingual carcinoma of the tip of the tongue. The second drawing illustrates a perfect reaction, in which the treated area is covered by a greenish-yellow fibrinous deposit. The edge is extremely sharply defined and the lesion now is not unlike an infarct (fourteen days after removal of needles). Six weeks later it is difficult to find any trace of the original lesion, as shown in the lower figure. Treatment: Implantation—5 needles. Active length, 15 mm. Linear intensity, 2 mc. Screen, 0·5 mm. of platinum. Time, 10 days.

marked as time progresses, and especially if slight over-treatment has been given. At the same time any induration becomes less distinct and in three to four weeks has disappeared, although the treated zone has still a different consistence and feels firmer than the healthy tissues. With a perfect response, in six to eight weeks' time little or no trace will be found of the original lesion. Mobility will at the same time have returned to normal. (*Fig.* 310.)

**Abnormal Reaction.** — Under-treatment is characterized by the fairly obvious feature of persistent induration, although ulceration may have disappeared.

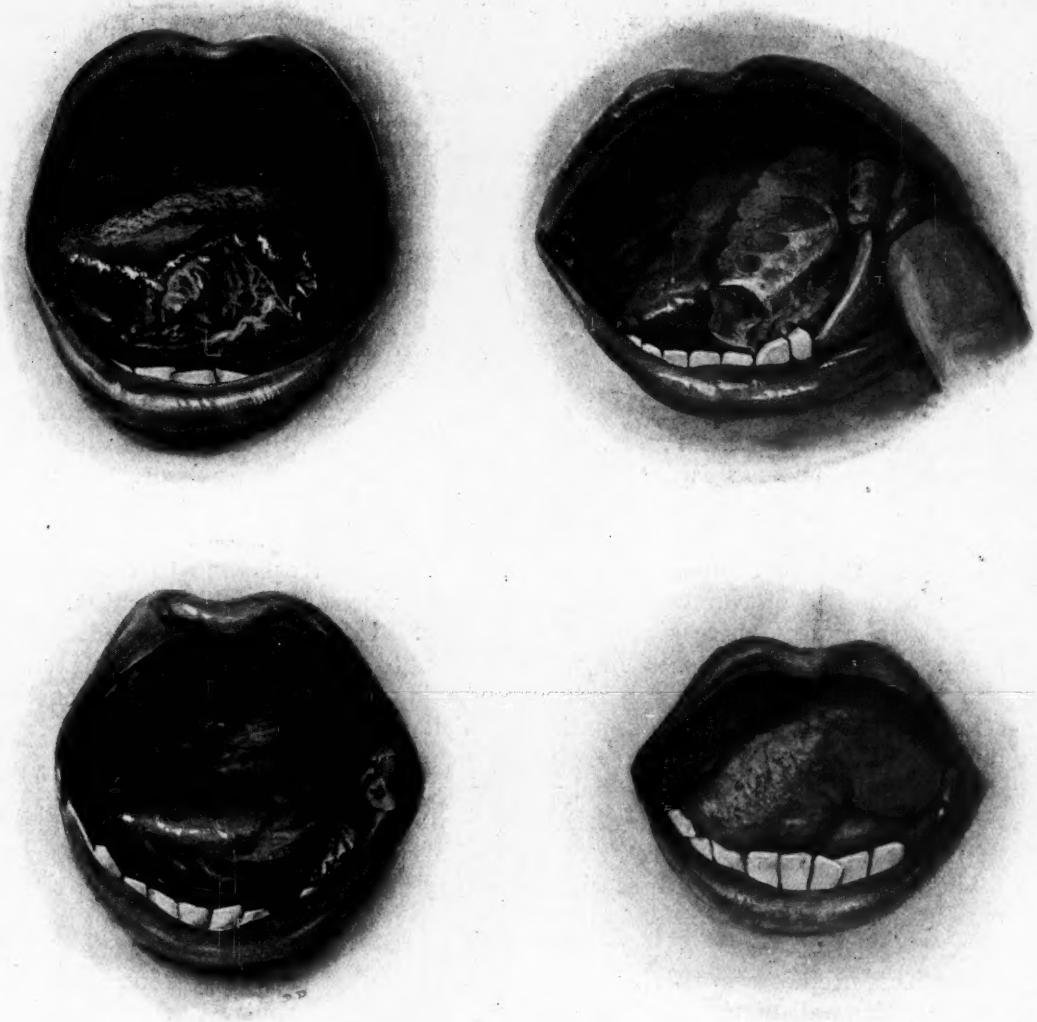


FIG. 311.—These drawings are from a case in which the reaction was slightly excessive. The second drawing was made nine days after the removal of the needles, and should be compared with the corresponding stage in *Fig.* 310. In the third a depressed ulcer is seen at the junction of the tongue and the floor of the mouth, eighteen days later. This took six weeks to heal, leaving a somewhat depressed and puckered scar. Treatment: Implantation—9 needles. Active length, 15 mm. Linear intensity, 2 mc. Screen, 0·5 mm. of platinum. Time, 9 days.

Over-treatment, leading perhaps to radium necrosis, often presents a difficult problem, and it is very probable that, before experience has been acquired, lesions so treated have received a second application under the impression that the growth has not been completely destroyed. This, of

course, only accentuates the condition, and from pain, sloughing, and consequent exhaustion from inability to sleep or take food the patient may succumb. Mild degrees of over-treatment are usually marked by the persistence of the fibrinous deposit to which reference has previously been made. Gross degrees show central ulceration of varying depths, and the edge of the ulcer is usually very sharply defined as though cut with a knife. The surrounding tissues are often œdematous and display a 'woody' type of induration. When the process has reached its maximum the base of the ulcer is covered by a very tough and adherent green slough. These ulcers are extremely painful and tender, and may take eight to twelve months to heal. A depressed scar results which causes puckering of the surrounding tissues and, if the tongue is the site of the lesion, may cause some limitation of mobility (*Fig.* 311). In some cases the ulceration has been so deep that a cul-de-sac lined by epithelium 5 to 10 mm. in depth, and perhaps 0·4 mm. in diameter, results. Necrosis of bone is sometimes met with when a lesion lies near to it, and this is particularly noticeable in the case of growths near the ascending ramus of the mandible and the alveoli. On the whole it is not very frequent, though some authors have advocated resection of the ascending ramus prior to irradiation of lesions involving the fauces. Naturally, when growth is definitely infiltrating bone, necrosis is inevitable. Certain workers advise protection of the lower alveolar margin and of the palate when tumours of the floor of the mouth and tongue respectively are being treated. In Manchester we have not found this to be necessary, nor does it appear reasonable to expect a mould composed of 1 mm. of lead, which only absorbs a minute percentage of $\gamma$ rays, to protect these structures efficiently. The secondary $\beta$ irradiation is absorbed by the tissues in which the needles are buried. As stated above, wearing of such apparatus is putting a good deal of additional strain on the tolerance of a patient, which must often have reached its limits already.

**Bronchopneumonia.** — The only noteworthy immediate complication of treatment is a bronchopneumonia, which we have found in two or three patients treated out of a total of 400. This is a relatively small number taking into account the oral sepsis and enfeebled condition of so many of the patients of the hospital class.

**Hæmorrhage.**—Severe hæmorrhage was noted in one of our own series whilst the needles were *in situ*. It was probably the result of ulceration through the wall of the lingual artery, and was easily controlled.

**Late Necrosis.**—Occasionally where a thick scar results—i.e., in those cases which have already been overtreated—ulceration may occur in the centre a year or more afterwards. It is probably due to a progressive endarteritis obliterans, and the breaking down is caused by some temporary superimposed effect, e.g., trauma or friction. Its occurrence in the centre of a lesion a considerable time after treatment, its comparatively rapid onset, the fact that it does not bleed, and that it is immediately lined by a tough, adherent slough, should lead to its detection. Naturally the possibility of recurrence should be borne in mind and the patient kept under close observation, but local recurrence a year or more afterwards is extremely uncommon if a high standard is observed in the assessment of a primary cure.

We have recently seen a case of necrosis of the mandible three years after the primary growth was treated and cured. Two applications were given to the primary growth, an ulcer persisting after the first treatment, which through our inexperience was not recognized as being due to over-treatment. The original lesion was in the middle third of the tongue anterior to the fauces.

## TREATMENT OF THE LYMPHATIC AREA.

When the primary lesion has been adequately dealt with, the treatment of the gland-bearing area has to be considered. When all the possibilities of spread are visualized, it will be realized that, no matter whether the original focus involves one or both sides of the mid-line, the area to be covered is a very extensive one. On theoretical grounds external irradiation at a distance would be ideal, but facilities are rarely available for it. The compromise of multiple foci near the skin has not yet shown that it is efficient, at any rate when palpable nodes exist. Finally, implantation would involve such an accurately spaced insertion of a very large number of needles that it would in itself be an almost impossible procedure, and with the surgical exposure necessary a block dissection might as well be performed.

There are three main types of case: (1) Those in which there are no palpable glands; (2) Those in which there are palpable glands, either unilateral or bilateral, and sufficiently mobile for a radical surgical removal; (3) Those in which there is unilateral or bilateral glandular involvement too fixed for surgical removal. Opinion varies a good deal as to the procedure in these cases, and the time has scarcely arrived when dogmatism is possible.

1. *Cases in which there are No Palpable Glands.*—It should be remembered that in certain cases metastasis never occurs, or, if it has done so, the lymphatic glands have dealt adequately with the malignant emboli. Surgical opinion would on the whole favour a block dissection if the lesion were unilateral, but opinion would by no means greatly lean towards a bilateral block dissection, owing to the severity of the procedure even when carried out in two stages. Probably the most conservative method is to irradiate both sides of the neck by multiple foci placed at a distance of about 2 cm. from the skin, as advocated by Cade in this country. The technique will be described later. Afterwards the patient is examined at monthly intervals, and a block dissection carried out should palpable nodes appear later.

2. *Cases with Palpable but Mobile Glands.*—Where palpable glands are present a block dissection should be carried out on the affected side. If both sides are involved a double block dissection should be done, with an interval of two to three weeks between the two operations, but the internal jugular vein should be removed on one side only. Probably the best radiological procedure is to follow this up a fortnight or so later by a prolonged external irradiation on the lines indicated in Class 1, but of course this is not an economical procedure with regard to beds or radium, and much will depend on local conditions and resources. It has been the practice in Manchester to implant from 10 to 15 needles of active length 15 mm., screen 0·8 mm. of

platinum, linear intensity 0·6 mgrm. radium element or 1·8 mc. of emanation, for seven days, in the wound but nothing like the same degree of homogeneous irradiation is achieved as by external irradiation, and of course the chances of sepsis are increased. Probably it is a sound procedure in all cases to implant a few needles close to the base of the skull, particularly when the primary lesion involves the fauces, lateral pharyngeal wall, or middle third of the tongue, as external irradiation is less likely to prove effective at this depth.

3. *Cases with Fixed Glands.*—It is doubtful whether external irradiation as commonly practised has ever 'cured' (in the five-year sense) a patient with fixed deposits in the neck secondary to a buccal carcinoma. Undoubtedly regression occurs, but so does recurrence, and the process cannot be repeated indefinitely, owing to the intolerance of the skin and to the immunization which follows non-lethal doses.

It is recognized that this question of immunization is not fully settled. However, if recurrence takes place in an area which has been irradiated, growth is often slower, and a fibro-neoplastic mass is formed, which is definitely more resistant to treatment. This may be due to the condition of the stroma. If irradiation is pushed, say, by a prolongation of the time period, the growth may disappear, but radio-necrosis is extremely probable.

Cade states that good palliative results follow the removal of as much of the growth as is possible surgically, combined with post-operative external irradiation, pushed to such an extent that the skin completely peels. In Manchester, this type of case, if not too advanced, has been treated exactly on the same lines as the primary growth, by implantation, and this is certainly worthy of trial if the palpable mass is limited to one group of glands.

If implantation is decided upon, incisions are made and flaps turned back as for a block dissection, and if the fixed glands are in the submaxillary or upper deep cervical groups, the sternomastoid is divided above the clavicle and reflected upwards. In this way a very good exposure of the anterior and posterior triangles of the neck is obtained, and accurate implantation is more easily performed. Usually needles are left *in situ* for a week, and removed under general anæsthesia. *Fig.* 312 is a diagram illustrating the implantation of needles in the wound after a block dissection has been performed. It is suggested that 0·8 mm. of platinum be used as a screen, so that only $\gamma$ rays of short wave-length are employed. Concentration of needles is directed to the group of glands which is most involved. Probably post-operative irradiation by multiple sources on a 'collar' is preferable, but the method has advantages where large numbers of cases are being treated and supplies of radium are limited.

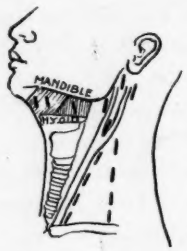



FIG. 312.—Illustrating the implantation of needles in the wound after block dissection.

**Block Dissection.**—No half measures should be adopted if surgery is decided upon. The removal of the internal jugular vein, together with the sternomastoid, is essential if a complete clearance of the gland-bearing area

is to be made. Not only does it enable this to be accomplished, but by giving better exposure it accelerates the operation. Regional anæsthesia or general anæsthesia is employed according to the preference of the individual surgeon, but it would appear that the former method might be carried out more frequently in view of the severity of the operation, and the fact that so many of the patients are over sixty years of age. If a block dissection is done on both sides, the internal jugular should be removed on the more affected side.

**External Irradiation.**—Cade recommends a Columbia paste collar 15 mm. in thickness. On it, and screened by 1 mm. of platinum or its equivalent in other metals, are disposed multiple foci containing 1·33 to 2 mgrm. of radium element and linear intensity 0·66 mgrm. In all about 50 to 70 mgrm. of radium element will be required. For post-operative irradiation seven to ten days' exposure for each side is about the average, but where the incomplete surgical eradication has been performed fourteen to twenty days' exposure will probably be required. It is impossible to be quite so definite with this method as with the primary site in detailing technique.

In prophylactic post-operative irradiation desquamation of the skin is the aim, but in the third class with fixed, inoperable deposits complete peeling is desirable.

From the above considerations it will be obvious that the purely radiological treatment of the lymphatic drainage area is not on a satisfactory basis. We feel that this is largely due to restricted supplies of radium and to the method employed. (If we consider the theoretical principles underlying treatment, implantation and surface application have considerable disadvantages.) Expediency must necessarily weigh most in the treatment of the individual; but the ideal method which must be tried, in the hope that greater quantities of radium may be forthcoming, is the employment of a large quantity of radium at a distance, which discounts both the human element and the physical disadvantages of current methods.

## RESULTS OF TREATMENT.

The results of treatment vary as one considers the primary lesion only or the cases as a whole.

There are no five-year figures available in this country, but Continental workers report about 45 per cent of five-year cures as regards the primary site, and 20 per cent of absolute cures. When one takes into account the fact that all cases treated are reckoned, and that a large proportion were hopelessly advanced at the very beginning, these are remarkable figures. It is particularly pleasing, too, that the percentage of recurrences at the primary site is very small, if a high standard is set with regard to cases deemed 'cured'.

The functional results are almost perfect, especially in the tongue. Mobility is scarcely impaired, and only slight defects are noted when the tongue is protruded fully. In general, if the lesion is unilateral, the tongue is deviated as a whole to the side of the lesion, and the tip points to the opposite side (*Figs.* 313, 314).

Even as a palliative procedure for the primary growth radium has amply justified itself as a therapeutic measure. The end of those patients who die of an untreated and unchecked primary growth is most distressing; death from metastatic complications is comparatively peaceful.

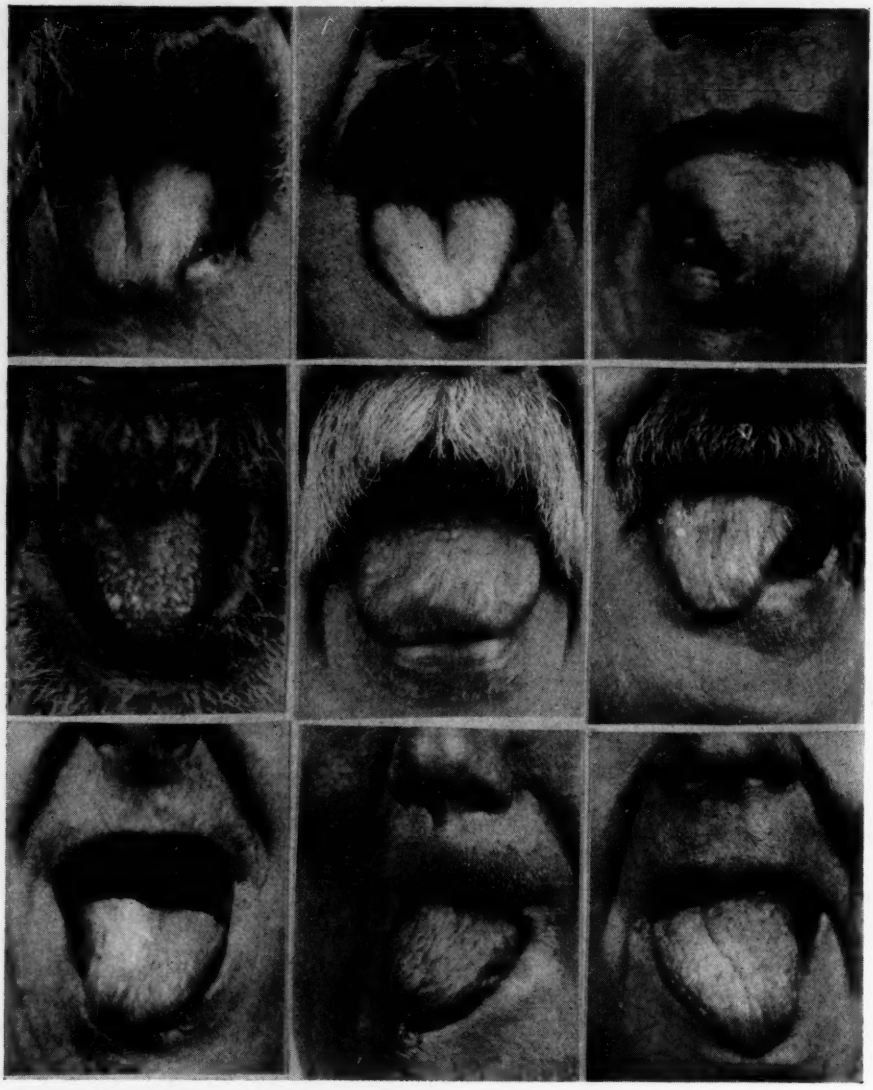


FIG. 313.—Photographs showing the good functional results after treatment. They were taken in March, 1928, and were selected only for the reason that the patients resided locally. All except one patient, who died of intercurrent disease, are still alive and well. A minor point of clinical interest is that, with a unilateral lesion, the tongue as a whole is drawn towards the affected side, whilst the tip points in the opposite direction. Before treatment the tip usually points to the same side as the lesion. In five of these cases there was microscopical evidence of deposits in the lymphatic glands. (*Reproduced by kind permission of the Editor of the 'Lancet'.*)

The table on p. 516 has been taken from an article by Regaud in the *American Journal of Roentgenology and Radium Therapy*, vol. xxi, January,

1929, No. 1. Unfortunately this does not give a true view of the situation, as percentage figures for all cases treated between 1920 and 1926 are given. The year 1922 is that on which the latest five-year figures can be based.

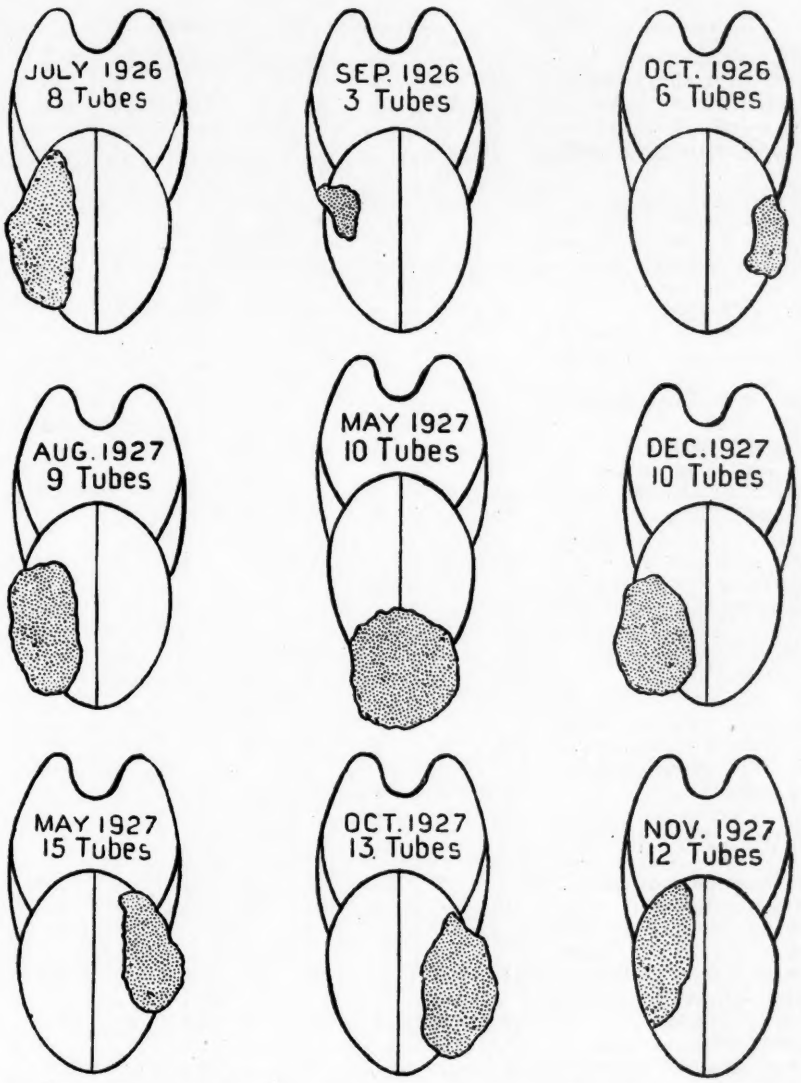



FIG. 314.—Key to the photographs shown in *Fig.* 313. All were moderately advanced cases with the exception of 2 and 3. (*Reproduced by kind permission of the Editor of the 'Lancet'.*)

The following table, which has been compiled from the one overleaf, gives the percentage figures for complete cure as assessed at the end of December, 1927 :—

| | 1922 | 1923 | 1924 | 1925 | 1926 |
|---|---|---|---|---|---|
| Total .. .. | 33 | 54 | 55 | 60 | 54 |
| Complete cure .. | 6 | 10 | 11 | 17 | 21 |
| Percentage .. .. | 18·18 | 18·50 | 20·00 | 28·33 | 38·88 |

CANCERS OF THE TONGUE AND OF THE FLOOR OF THE MOUTH. TOTAL STATISTICS OF TREATED CASES AND RESULTS, 1920–6.

(Revised Dec. 31, 1927.)

| | 1920 | 1921 | 1922 | 1923 | 1924 | 1925 | 1926 | TOTALS | PERCENTAGE |
|---|---|---|---|---|---|---|---|---|---|
| Number of treated cases .. | 55 | 41 | 35 | 56 | 59 | 65 | 56 | 367 | |
| Cases which were eliminated.. | 2 | 6 | 2 | 2 | 4 | 5 | 2 | 23 | |
| Cases retained for statistics .. | 53 | 35 | 33 | 54 | 55 | 60 | 54 | 344 | |
| 1. Anterior dorso-lingual localization .. .. .. | 20 | 22 | 19 | 24 | 34 | 39 | 27 | 185 | |
| *a.* Complete cure .. .. | 5 | 6 | 3 | 6 | 9 | 9 | 11 | 49 | 26·4 |
| *b.* Cure of local lesion of tongue. Death from secondary adenopathy .. | 6 | 7 | 8 | 10 | 7 | 4 | 4 | 46 | 24·8 |
| *c.* Failure to arrest primary lesion of tongue .. .. | 9 | 9 | 8 | 8 | 18 | 26 | 12 | 90 | 48·6 |
| Permanent arrest of primary localization taken by itself | .. | .. | .. | .. | .. | .. | .. | 95 | 51·3 |
| 2. Posterior dorso-lingual localization .. .. .. | 16 | 5 | 6 | 18 | 14 | 12 | 11 | 82 | |
| *a.* Complete cure .. .. | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 16 | 19·5 |
| *b.* Cure of local lesion of tongue. Death from secondary adenopathy .. | 2 | 0 | 0 | 5 | 4 | 2 | 1 | 14 | 17·0 |
| *c.* Failure to arrest primary lesion of tongue .. .. | 13 | 3 | 3 | 12 | 8 | 7 | 6 | 52 | 63·4 |
| Permanent arrest of primary localization taken by itself | .. | .. | .. | .. | .. | .. | .. | 30 | 36·5 |
| 3. Infra-lingual localization .. | 17 | 8 | 8 | 12 | 7 | 9 | 16 | 77 | |
| *a.* Complete cure .. .. | 0 | 3 | 0 | 3 | 0 | 5 | 6 | 17 | 22·0 |
| *b.* Cure of local lesion of tongue. Death from secondary adenopathy .. | 3 | 2 | 0 | 1 | 2 | 0 | 1 | 9 | 11·6 |
| *c.* Failure to arrest primary localization .. .. | 14 | 3 | 8 | 8 | 5 | 4 | 9 | 51 | 66·2 |
| Permanent arrest of primary localization taken by itself | .. | .. | .. | .. | .. | .. | .. | 26 | 33·7 |
| 4. All localizations combined.. | 53 | 35 | 33 | 54 | 55 | 60 | 54 | 344 | |
| *a.* Complete cure .. .. | 6 | 11 | 6 | 10 | 11 | 17 | 21 | 82 | 23·8 |
| *b.* Cure of local lesion of tongue. Death from secondary adenopathy .. | 11 | 9 | 8 | 16 | 13 | 6 | 6 | 69 | 20·0 |
| *c.* Failure to arrest primary lesion of tongue .. .. | 36 | 15 | 19 | 28 | 31 | 37 | 27 | 193 | 56·1 |
| Permanent arrest of primary localization taken by itself | .. | .. | .. | .. | .. | .. | .. | 151 | 43·8 |

From these figures it appears that if a patient survives three years without recurrence there is a reasonable chance of permanent cure.

In Manchester our figures for 1926, 1927, and 1928, which correspond practically with those for 1924–6 in Regaud's series, are as follows :—

| | 1926 | 1927 | 1928 |
|---|---|---|---|
| Complete cure .. .. | 18 | 25 | 51 |
| Total .. .. .. | 80 | 74 | 113 |
| Percentage .. .. | 22·50 | 34·7 | 45·13 |

These figures include all localizations in the mouth; Regaud's figures include only the tongue, infralingual surface of the tongue, and floor of the mouth.

I am indebted to Miss D. Davidson for the coloured drawings in the text.

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[4] Birkett, G. E., "Radium Treatment in Carcinoma of the Mouth and Tongue", *Lancet*, 1928, May 12.

# A CASE OF SOLITARY PLASMA-CELLED MYELOMA.

By HERBERT ROGERS,

ASSISTANT PATHOLOGIST AT THE BRISTOL GENERAL HOSPITAL.

Spontaneous fracture of a long bone due to tumour growth is almost always a sign of serious import in clinical surgery. It is, however, becoming recognized that there is a primary and solitary tumour of the marrow which in most cases gives rise to spontaneous fracture, and which is innocent in its behaviour. This growth is composed of cells morphologically identical with the plasma cell of subacute inflammation, and seems to bear no relation to generalized myelomatosis or to osteoclastoma.

## CASE REPORT.

History.—F. C. C., a male, age 34 years. Occupation, labourer. In November, 1927, the patient fractured the shaft of his right femur by slipping on a pavement, with little or no violence. Treated by weight extension and massage, he progressed favourably until Christmas, 1927, when he accidentally injured the damaged femur. This injury produced swelling, but little pain, and the limb was put up in plaster for six weeks. He was admitted into the Bristol General Hospital on June 21, 1928, under the care of Professor Hey Groves.

On Examination.—A large fusiform swelling was seen on the front and inner aspects of the right thigh. The swelling was firmly attached to the bone, and of a semi-solid consistency. No defined 'edge' could be felt, and no 'egg-shell crackling' elicited. No 'thrill' or 'bruit' was present, and the shaft of the femur appeared to be rigid.

*X-ray Examination.*—This showed a honeycombed appearance in the mass of callus uniting the fracture, and a rarefaction of the bone extending for a short distance above and below the site of injury (*Fig.* 315).

First Operation.—On June 22 the tumour was explored through an incision in the outer side of the thigh. The mass was completely enveloped by periosteum, and a large quantity of soft, fleshy growth was scooped out by means of the finger and a sharp spoon, leaving a large cavity which bled freely. The cavity was tightly packed with gauze.

On July 3, radium needles (150 mgrm.) were inserted into the cavity, and removed on the following day. The patient progressed satisfactorily and was discharged to a convalescent home on Aug. 13.

Re-admission.—On Nov. 22 the patient was re-admitted to hospital. There was a thin purulent discharge from a sinus in the operation area, and the muscles of the leg showed very considerable wasting.

X-ray examination showed no evidence of reparative bone formation,

and the appearances suggested that tumour tissue had not been completely removed or that a recurrence had taken place.

SECOND OPERATION.—On Nov. 27 the area was explored, using the same route as in the first operation. A whitish, mushy material was found in place of the original growth, filling a well-defined cavity. Portions were removed for examination, the remainder scraped out, and radium needles packed in; 140 mgrm. were used and removed two days later.

Progress was satisfactory for a week or ten days, but a purulent discharge became profuse and the patient complained of pain.

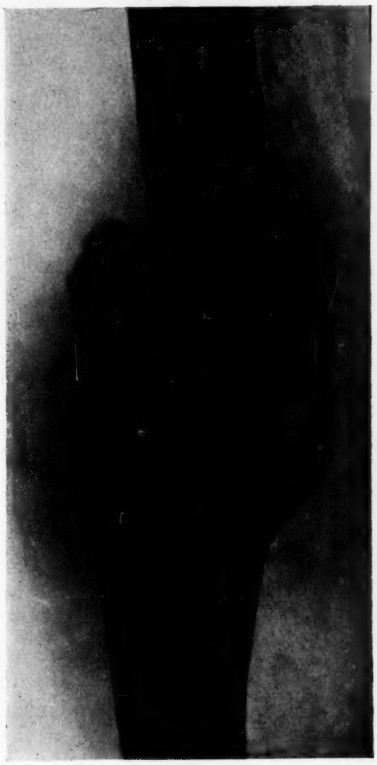

FIG. 315.—Skiagram showing honeycombing of callus uniting the fracture.

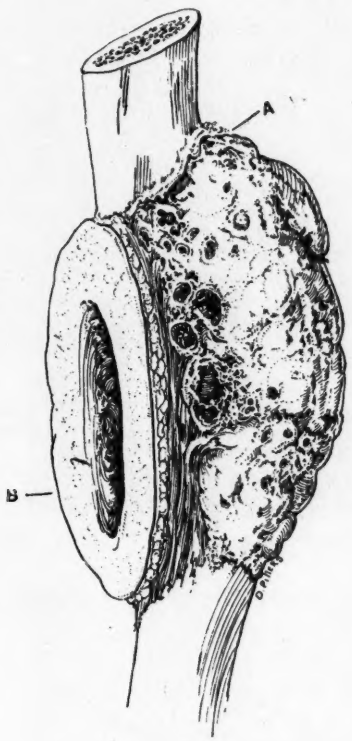


FIG. 316.—The femur after amputation. A, Site of fracture from extension of growth up the bone; B, Skin.

THIRD OPERATION.—On Jan. 8, 1928, the femur was again exposed by Mr. Hey Groves, large quantities of avascular granulation tissue were removed, and the cavity cleansed by peroxide of hydrogen followed by absolute alcohol. It was then dried thoroughly by means of hot air, and Mr. L. E. Claremont filled the cavity with plaster-of-Paris. During the next few days there was a rise of temperature, pulse, and respirations. The purulent discharge was considerably lessened, but constant pain and mobility at the site of the tumour, indicating a re-fracture, made amputation advisable.

On Feb. 5 amputation was performed through the upper third of the thigh. The patient recovered strength rapidly; the stump healed completely and satisfactorily.

EXAMINATION OF MATERIAL REMOVED AT FIRST OPERATION.—The tumour masses were of a firm consistency and presented a greyish-white appearance, with many areas of hæmorrhage. Microscopically the sections show masses of small round or polyhedral cells, separated by fibrous tissue septa, and interspersed with small areas of hæmorrhage (*Fig.* 317). Under a higher

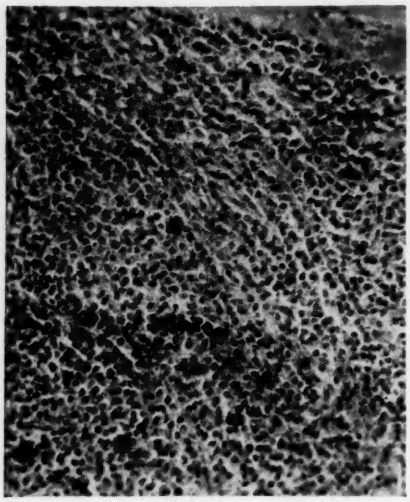

FIG. 317.—Low-power photomicrograph of tissue removed at first operation, showing general arrangement of tumour cells.

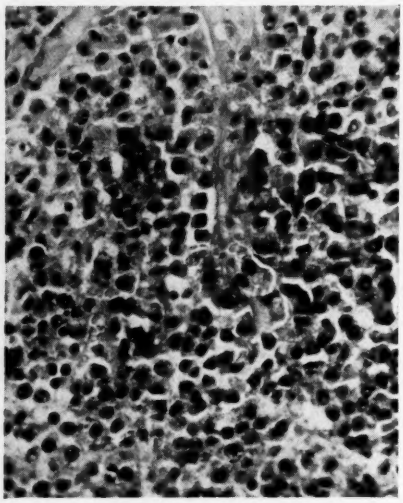

FIG. 318.—High-power photomicrograph of tumour, showing typical cell appearance and scanty stroma.

magnification (*Fig.* 318) the cells are on the whole discrete and separated from each other by a scanty matrix, but exhibit a tendency to form short columns. They are polyhedral in shape, and possess a round or oval nucleus situated eccentrically. The cytoplasm of the cells is amphophilic and non-granular ; and the nucleus, staining well with hæmatoxylin, is of a typical ' cart-wheel ', or ' clock-face ', type. Few mitoses are seen and no multinucleated cells. A few of the cells show degenerative changes, such as swelling, vacuolation, loss of nuclear outline, and disappearance of the nucleus. Staining with the Unna-Pappenheim method is typical, and a diagnosis of myeloma of plasma-celled type was made.

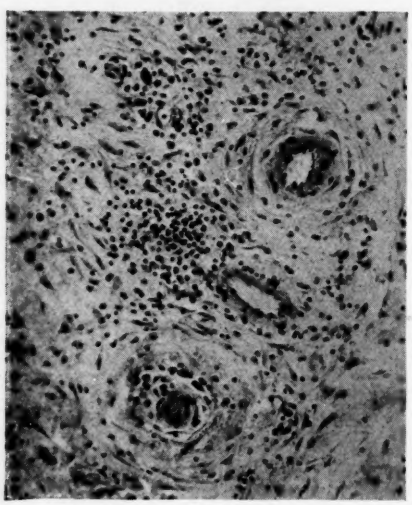

FIG. 319.—Material removed at second operation, consisting of granulation tissue, with round-cell infiltration and islands of plasma cells and lymphocytes.

A blood-count showed only a mild secondary anæmia, with no abnormality in the red or white cells. No Bence-Jones proteosuria could be demonstrated. X-ray examination of the skeleton did not reveal any other foci of tumour formation.

EXAMINATION OF MATERIAL REMOVED AT THE SECOND OPERATION.—The portions of tissue removed from the cavity vary slightly from a structureless matrix to well-formed fibrous tissue and vascular granulation tissue. Islets of plasma cells, lymphocytes, and small round cells are found in most of the sections, but there is no structural resemblance to the tumour formation originally present (*Fig.* 319).

EXAMINATION OF THE MATERIAL REMOVED AT THE THIRD OPERATION.—The material appears to be entirely necrotic except for areas of fibrous tissue containing chronic inflammatory cells. There is no histological evidence of new growth.

APPEARANCE OF THE FEMUR AFTER AMPUTATION (*Figs.* 316, 320).—The specimen consists of the lower three-quarters of the right femur. In the middle third of the shaft there is a fusiform swelling measuring $4\frac{1}{2}$ in. long and $2\frac{1}{4}$ in. at its greatest diameter. This enlargement is formed by a shell of bone, in some places no thicker than parchment, constituting the walls of a cavity originally occupied by the new growth of the marrow, and now devoid of contents. In some places the bony shell appears to have been perforated, the periosteum alone forming the capsule of the growth at these points.

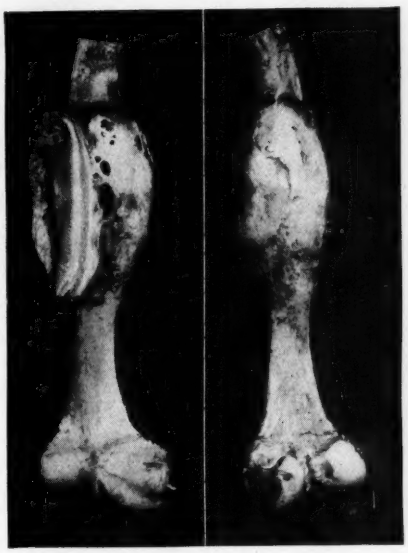

FIG. 320.—The lower two-thirds of the femur after amputation, showing fusiform swelling and original incision through the soft tissues.

On the antero-external aspect the soft tissues, including the partially healed skin incision, have been left adherent to the margins of the cavity from which the tumour was removed. The shaft of the femur above and below the bony swelling is normal in size and structure.

## COMMENTS.

While multiple myeloma of plasma-celled type is of comparatively common occurrence, cases showing one solitary focus of new growth appear to be very rare. Aschoff[1] refers to cases recorded by Kunosoki and Frank. Kolodny[2] (1927) states that only one case is recorded in the Registry of Bone Sarcoma of the American College of Surgeons, and Ewing[3] (1928) does not refer to their occurrence in his *Neoplastic Diseases*,. Shaw[4] (1923) has published an account of a case which was completely cured by bone-grafting after excision of the segment of bone affected by the new growth. Stewart and Taylor[5] (1928) investigated a number of cases of plasmocytoma ; in one case a second focus of growth appeared in the frontal bone after the original myeloma had been removed from the maxilla, and disappeared under X-ray treatment.

The solitary plasma-celled myeloma is a new growth which arises in the

bone-marrow, and appears to occur more frequently in the long bones than in flat bones or vertebræ. The origin of the tumour is still a matter of dispute; the type cell is believed to be derived either from a lymphocytic cell or from the perivascular endothelium.

Ewing's sarcoma may be mistaken for myeloma when sections are overstained with hæmatoxylin (Kolodny, 1927), and plasma cells may be found in these tumours. Ewing's sarcoma, however, is an endothelial tumour, and, according to Ewing[6] (1924), is probably derived from perivascular lymphatic endothelium.

In the case of plasma-celled myeloma recorded in this paper the histology of the reparative process after removal of the new growth is of interest, especially regarding the use of radium. It seems probable that the use of radium in large doses has brought about a condition of 'radium necrosis', which has not only prevented any attempt at recurrence on the part of the tumour tissue but has placed the natural reparative reactions of the healthy structures in abeyance. The possibility of such an eventuality must evidently be kept well in mind when radium is employed, as the clinical evidence of the necrotic influence may be delayed for ten days or a fortnight.

I am indebted to Mr. Hey Groves for permission to make full use of his clinical notes, to Dr. A. L. Taylor for his help and advice in the investigation of the histological material, and to Dr. G. B. Bush for the skiagram.

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[2] Kolodny, A., *Bone Sarcoma*, 1927, 160, 162.
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[4] Shaw, A. F. B., *Jour. Pathol. and Bacteriol.*, 1923, xxvi, 125.
[5] Stewart and Taylor, Unpublished investigations.
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# THYROID METASTASES IN BONE.

By W. K. CONNELL, Dar-es-Salaam,
MEDICAL OFFICER, EAST AFRICAN MEDICAL SERVICE.

The subject of this paper is an extremely controversial one, to be approached only with an open mind and in a spirit of inquiry. Its importance, however, can scarcely be denied, touching as it does on the vital question of whether or not benign tissues can disseminate. According to most accredited pathologists, dissemination is a feature of malignant tumours and of these alone; but to challenge accepted views is sometimes instructive and is always of interest. It is a truism that no convincing definition of malign, as opposed to innocent, tumours exists; and, in place of a definition, we have to content ourselves with mere tabulated lists of characteristics supposed to be pathognomonic of the two classes of neoplasm.

My interest in thyroid osseous metastases has recently been quickened because within the past two and a half years I have encountered two such cases in Tanganyika Territory.

## CASE REPORTS.

*Case* 1.—An African woman, age about 50 years, was admitted to Songea Hospital (situated about one hundred miles from Lake Nyasa) on Sept. 2, 1926. She had a large, soft, fleshy lump on the back of the left side of the head; it was adherent to the skin and covered with a network of enormously dilated veins. She complained of considerable pain in the region of the lump; there was no enlargement of the cervical glands. There was a small, hard, apparently completely encapsuled lump, of about the size of a walnut, in the right lobe of the thyroid gland; it had no features suggestive of malignancy, and the patient, though aware of its existence, had thought it too trivial to bring to my notice. She said that her thyroid lump had first appeared about three years previously and that the cranial lump had begun to develop about one year later. The latter had been of very slow growth. When seen by me it was the size of a very large orange. I tried to obtain a wedge of the tumour for section, but hæmorrhage was so furious that I had to abandon the attempt. The tumour was thus of an intensely vascular nature.

In the usual manner of Tanganyika natives, my patient, when she realized that there was no likelihood of a sudden and dramatic cure being produced, soon absconded from hospital.

It may be objected in this case that the cranial tumour may have been a primary malignant growth, the thyroid swelling being merely a coincidence. It is unlikely, however, that a primary malignant tumour of the skull could have existed for two years without at least fungating.

*Case* 2.—An African woman, of the Mkami tribe (Morogoro district), age about 45 years, was admitted to the Sewa Hadji Hospital, Dar-es-Salaam, on Feb. 21, 1929, complaining of a large and painful lump on the back of the head of three years' duration. There was a fleshy mass about the size of an ostrich's egg projecting

from the occipital region of the skull (*Fig.* 321). It was apparently fixed to the subjacent skull and the scalp could not be moved over it. There were dilated veins in the overlying skin. Further examination revealed that there was a hard and slightly nodular lump (of hen's egg size) in the left lobe of the thyroid gland. This lump was freely movable on the deep structures and was quite unattached to the skin ; it rose and fell freely on deglutition. Apart from its hardness and its slightly nodular surface, it had no features of malignancy whatever. In the right subclavian triangle I found a hard and somewhat fixed gland of about walnut size ; but apart from this no enlargement of the cervical glands could be detected. The patient apparently attached no importance whatever to her neck condition, and could scarcely conceal her impatience when I examined it and questioned her about it. She said that she had had a lump in her neck ever since childhood, but that it had never caused trouble. She could not say that this lump had recently been increasing in size.

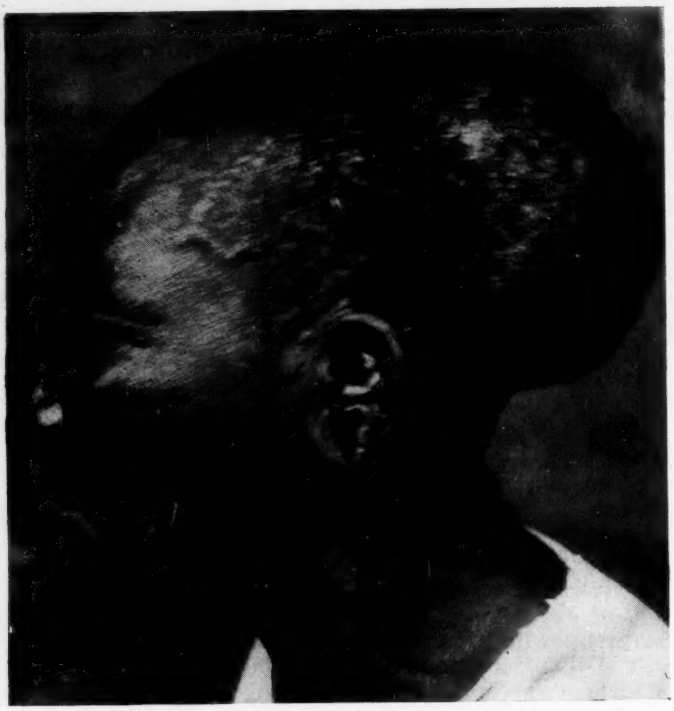

FIG. 321.—*Case* 2. Appearance of the tumour.

Mr. J. E. Brunnen, of the Electricity Department, very kindly radiographed the skull for me. The X-ray picture shows that the outer table, diploë, and a part of the inner table of a considerable portion of the occipital region of the skull had been destroyed and replaced by growth (*Fig.* 322); expansion had, however, been chiefly at the expense of the outer table.

On March 18, I removed a wedge of the tumour for section. The growth had an appearance as of encapsulation, but as the 'capsule' was extremely hard and difficult to cut, I formed the impression that it was really the thinned-out relic of the outer table of the skull. The tumour itself was extremely pale and of a rather waxy appearance.

This patient followed the example of the previous one in absconding from hospital before the condition could be further studied. There was, in any case, little to be done for her. Excision of the tumour would have entailed removing the whole of the occipital region of the skull.

FIG. 322.—*Case* 2. Radiograph showing destruction of part of the occipital region of the skull.

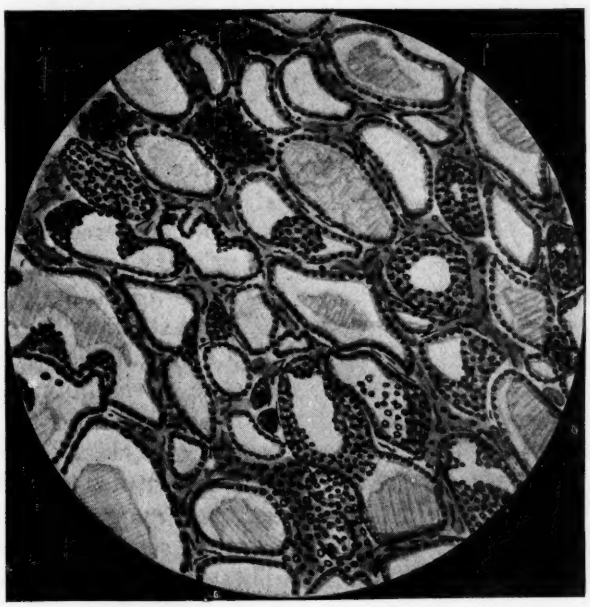

FIG. 323.—*Case* 2. Microscopic appearance of tissue removed.

Dr. H. O'D. Burke-Gaffney, of the Dar-es-Salaam Laboratory, examined the portion of tissue which I had removed. His report was as follows :—

"The structure of the tumour mostly resembles the type of fœtal adenoma. There are numerous empty tubules, surrounded in part by a vascular stroma. Some of these are dilated and contain secretion. In other parts there are irregular acini containing true colloid. Between these in some areas are masses of cuboidal cells which do not form acini. The tumour would appear to be an adenocarcinoma—subsequent to a fœtal adenoma which has developed malignant changes. Such a diagnosis is made chiefly from the metastatic nature of the growth. The essential histological changes mostly resemble both simple and fœtal adenomata. It would be difficult to identify a carcinomatous element from the appearance only." (*Fig.* 323.)

## GENERAL FEATURES.

The occurrence, in or on bones, of tumours containing thyroid tissue has long been recognized, but the nature and origin of these deposits have given rise to much speculation. That they can occur as 'orthodox' metastases in cases of unequivocal thyroid cancer is undoubted, Pemberton[1] assessing the incidence at 6 per cent, while Ewing[2] holds that cancer of the thyroid is second only to that of the breast and prostate in the production of skeletal secondaries. Their relation, however, to the phenomenon of 'general thyroid malignancy' at once presents us with a problem which has never yet been solved. That tumours structurally identical with the thyroid gland can appear in the bones of patients whose thyroids are, judged clinically, either normal or else the seat of a simple growth or goitre, is a fact not easily explained ; and what Jacobson[3] has called 'the mysterious malignant adenoma' has so far baffled pathology. However produced, these deposits are oftenest found in women of from 40 to 65 years of age.[3]

The skull bones are the commonest sites for these growths, but they have also been found in the sternum, vertebræ, ribs, humerus, femur, pelvis, and clavicle, and approximately in that order of frequency.[2] Thyroid 'rests' or inclusions may possibly explain a few cases, but it is a fact that the bones least likely to contain aberrant thyroid tissue are the ones most commonly attacked by 'metastasis', and even the clavicle and sternum are developed in a plane altogether anterior to that of the thyroid *Anlage*.

Thyroid metastases make their first appearance, as a rule, in the vicinity of the cranial sutures or of the epiphyses of the long bones.[2] They may be encapsuled or diffuse, endosteal or periosteal, and they are sometimes osteoplastic, so that a pathological fracture due to their presence may ultimately unite.[2] They have often been mistaken for primary sarcomas of bone.[2] Some are pale and almost bloodless (as in *Case* 2), while others are so intensely vascular and display such vigorous pulsation that they have been mistaken for aneurysms. Cramer was thus misled by a sternal deposit, which he treated by ligature of some of the great vessels. (*Case* 1 was intensely vascular, but it did not pulsate.) Many of these deposits function after the manner of the thyroid gland—for example, in one of Eiselsberg's cases, 'tetany' (? cachexia strumipriva) followed the removal of a carcinomatous thyroid, was relieved when a secondary appeared in the sternum, and reappeared when the sternal growth was excised.[2] Ewald has shown that, in some cases of thyroid adenocarcinoma which are iodine-free, iodine has been detected in an osseous deposit.[2]

A thyroid osseous metastasis is usually slow in its growth. It had existed for two years in *Case* 1 and for three in *Case* 2. In a case of Halpérine's the metastasis had been present for twenty years—a fact which might well throw some doubt on its malignant nature.[4]

Ehrhardt maintained that thyroid osseous metastases were *never* single, and that multiple deposits were always to be found in cases that came to autopsy. He therefore considered that their surgical treatment was useless.[2] Joll,[4] on the other hand, says that the osseous growth may be the sole metastasis present in the body, and that "this has been confirmed by careful post-mortem examinations". He has not, however, quoted a single case to support this contention, nor have I been able to find any proof of it in the literature at my disposal.

The histology of thyroid metastases is extremely varied and often 'mixed'; so that their structure may be that of a carcinoma, an adenocarcinoma, a 'fœtal adenoma', a simple parenchymatous or colloid goitre, normal thyroid gland tissues, or combinations of any two or more of the foregoing.

## DIAGNOSIS.

These growths are specially liable to be mistaken for primary sarcomas; diagnosis, except by the microscope, may be impossible. Radiography can do little more than establish the neoplastic nature of the bony swelling, though of course a periosteal sarcoma might show a definite 'skeleton'. Trotter[5] warns us that "a diagnosis of primary malignant disease of the skull should never be made until the presence of malignant disease elsewhere has been excluded. Examination should be directed especially to the thyroid, kidney, breast, and prostate". One would strongly suspect a thyroid origin in the case of bone growth affecting an elderly woman with some pathological condition of the thyroid gland, particularly if the breasts were normal.

With a metastasis in the skull (the commonest site for such deposits), we would have to eliminate sarcoma (remembering that periosteal sarcoma is the commonest primary tumour of the skull); ivory osteoma; cerebral meningioma involving the skull by direct extension; inflammatory hyperostosis—perhaps syphilitic; dermoid cyst; lipoma; meningocele and the allied conditions; hæmatoma; and subpericranial abscess. Most of these could be rapidly excluded. A deposit in the sternum might closely simulate aortic aneurysm (as in Cramer's case); whilst a vertebral deposit causing angular curvature and paraplegia (as in cases reported by Horsley and Hebbs) might easily be confounded with Pott's disease of the spine.

The nature of both my cases was strongly suspected from the beginning. I unfortunately lacked facilities for establishing the diagnosis of *Case* 1, but in *Case* 2 the metastasis was examined both by radiography and by the microscope.

## PROGNOSIS AND TREATMENT.

Bland-Sutton[6] says: "In many instances these secondary tumours have been subjected to operative treatment, and on the whole with satisfactory results", a statement which is borne out by the cases which Joll has recorded —notably Kraske's case in which there was no recurrence after eight years.

A good deal probably depends on whether or not the metastasis is single, and though Ehrhardt maintained that this was never the case, he was probably too pessimistic. Barthels[7] states that "a primary malignant tumour of the thyroid gives a worse prognosis than a metastatic growth", and it certainly appears that the type of thyroid carcinoma which produces bone deposits is unusually 'chronic' and of relatively low virulence.

In the present state of our knowledge it would probably be good practice to remove a single bone metastasis, provided the risk was not excessive, and to follow this up with thyroidectomy. Prophylaxis is, of course, a matter of removing the 'pre-malignant adenoma'. In other words, all tumours of the thyroid should be suspect and their treatment should be that of a potentially malignant growth.

## SUMMARY.

1. The discovery, within a short period, of two cases of thyroid bone metastases, affecting natives of the Tanganyika Territory, is a fact of some interest.

2. The general features of thyroid osseous metastases are discussed.

3. The view is taken that all such cases are probably dependent on the presence of a thyroid carcinoma, which, however, may be so atypical, so slow and insidious, that its true nature is apt to be overlooked.

4. It is incredible that a malignant thyroid can produce a benign metastasis.

5. The suggestion that a benign thyroid may produce either a benign or a malignant metastasis is less unreasonable, and is certainly supported by a good deal of incomplete clinical and histological evidence. At present we can only return a verdict of 'not proven'.

6. Where the risk is not excessive and the metastasis is apparently single, the treatment recommended is excision of the metastasis, followed by thyroidectomy.

7. Prophylaxis depends on removing all thyroid tumours as soon as recognized.

My thanks are due to Dr. J. O. Shircore, D.M.S.S., Tanganyika Territory, for permission to submit this article for publication.

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# THE ANATOMY (COMPARATIVE AND EMBRYOLOGICAL) OF THE SPECIAL THYROID LYMPH SYSTEM, SHOWING ITS RELATION TO THE THYMUS:

## WITH SOME PHYSIOLOGICAL AND CLINICAL CONSIDERATIONS THAT FOLLOW THEREFROM.

By G. SCOTT WILLIAMSON and INNES H. PEARSE,

DUNN LABORATORIES, ST. BARTHOLOMEW'S HOSPITAL, LONDON; LABORATORIES OF THE ROYAL COLLEGE OF SURGEONS, LINCOLN'S INN FIELDS, LONDON.

The lymphatic system of the thyroid has attracted the attention of the anatomist from the earliest time. The reason for this is in itself significant. The thyroid is the only gland in which under natural conditions the lymphatic system is found with great frequency to be active and distended with lymph and lymphocytes. The histologist, therefore, had not to await the results of injection and experiment to demonstrate the lymph system in the thyroid gland.

### THE INTRA-THYROIDAL LYMPH SYSTEM.

Lymph spaces within the thyroid have been described in particular by Boechat[1] in 1873, Biondi[2] in 1888, Hürthle[3] in 1894, Müller[4] in 1896, Régaud and Petitjean[5] in 1909, and by Matsunaga[6] in 1909. Boechat's[7] description still stands to-day as comprehensive: ". . . on a, en effet (dans le corps thyroïde) un épithélium réposant sur un endothélium, mais il est à remarquer qu'içi l'endothélium sous-épithélial fait partie d'un sinus lymphatique". In our first study of the gland[8] we confirmed Boechat's view. Each follicle of the thyroid lies in a lymph space so arranged that the thyroid epithelium is bathed directly by any lymph contained therein (*Fig.* 324). Groups of such follicles with their perifollicular spaces are enclosed in a fibro-elastic capsule lined by endothelium (*Fig.* 324). Within the limit of this lining endothelium the perifollicular spaces are continuous one with another, forming slit-like channels

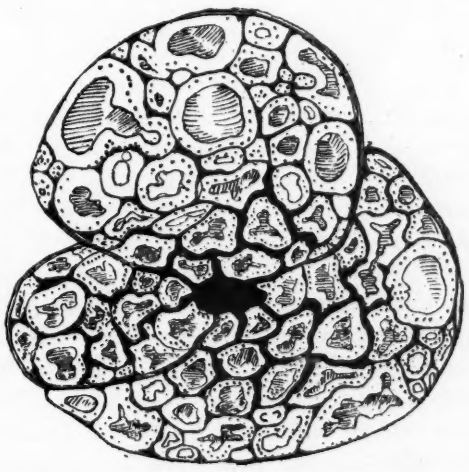


Fig. 324.—Drawing of three encapsuled groups of follicles showing their perifollicular lymph spaces or sinusoids emptying into a common central lymph space—the intra-lobular lymphatic.

running between the individual follicles. These channels are portions of the endothelial-lined sac rendered visible by fluid contents. It is to this endothelial sac with all its tortuous interfollicular channels that we have given the name "*lymph sinusoid.*" Each lymph sinusoid within which are packed columns of thyroid epithelium and a blood-capillary plexus represents one "*gland-unit.*"* Groups of these encapsuled gland-units are regularly clustered about a central lymphatic channel into which their sinusoids open freely (*Fig.* 324). They are bunched around this channel like grapes about a stalk. Each bunch of gland-units forms a lobule of the gland and is enclosed in a special compartment of the interstitia.[9]

This arrangement is an analogous one to that found in the liver lobule.† In the liver, groups of blood sinuses, each containing columns of liver epithelium, a 'Kupffer cell plexus'‡, and blood sinusoids are clustered about a central vein, the hepatic vein; into this vein the portal blood sinusoids open. The difference in structural arrangement between these organs is that in the thyroid *lymph takes the place of portal blood.* From this it is safe to infer that the lymph is as significant to thyroid function as the portal blood is to liver function.

**The Interstitial Lymph Channels.**—Let us follow the course of the thyroid lymph from these lobules through the gland. The central intralobular lymph channels which receive their lymph from the sinusoids leave the lobules and unite in the interstitial tissue of the gland. Here again we find a peculiarity about the arrangement of the specific lymph-vessels. They run in the course of the branches of the main artery to the gland, the inferior thyroid artery.[13] From the gland they emerge as a number of discrete trunks on the postero-mesial surface of each lobe at the well-marked hilum—that is, at the point of entry of the inferior

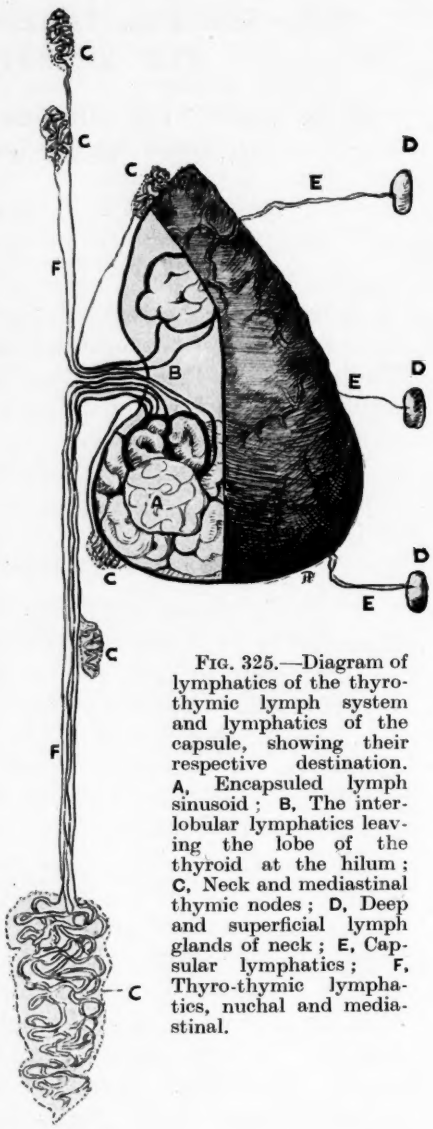



FIG. 325.—Diagram of lymphatics of the thyro-thymic lymph system and lymphatics of the capsule, showing their respective destination. A, Encapsuled lymph sinusoid; B, The interlobular lymphatics leaving the lobe of the thyroid at the hilum; C, Neck and mediastinal thymic nodes; D, Deep and superficial lymph glands of neck; E, Capsular lymphatics; F, Thyro-thymic lymphatics, nuchal and mediastinal.

* By gland-unit we mean the unit-area of associated tissues (epithelium, blood capillaries, lymph spaces, etc.) necessary for the exercise of the specific function of any gland.[8]

† According to Delépine,[10] Mall,[11] and McNee.[12]

‡ The Kupffer cells of the liver sinusoids are reticulo-endothelial cells and similar in every way to the reticulo-endothelial cells of the thyroid sinusoids. (*See* Williamson and Pearse, *Jour. Pathol. and Bacteriol.*, 1926, xxix, 167.)

thyroid artery. It is noteworthy that the specific thyroid lymphatics, which we are describing here, do not follow the course of the veins as is commonly the case in most other organs. The veins leave the thyroid by the shortest route and emerge in the capsule over the whole surface of the gland. These veins have their 'lymphæ comites' which drain into the nearest lymphatic glands (Poirier[14]), and it is these 'lymphæ comites' of the veins which alone, up to the present, have been familiar to physiologists and surgeons. In the thyroid, however, we are presented with another lymphatic system which runs a specific course of its own within the gland and emerges as a collection of discrete vessels from the hilum of each lobe (*Fig.* 325).

FIG. 326.—Drawing of the anterior aspect of a specimen of a thyroid and thymus taken post mortem, showing the fibrotic cords of lymphatics (Piersol's ligament) uniting the two organs. The leash of lymphatics on the left side is cystic.

**The Destination of the Special Thyroid Lymph-vessels.**—The fact that the special thyroid lymph channels are often naturally distended with lymph and occasionally with lymphocytes enabled us to trace them in serial sections to their termination. They can be followed in continuity from the

FIG. 327.—Cystic distension of the essential endothelial spaces of the thyroid. The material found in these cysts contains neither iodine nor thyroxin: they are therefore distinct from the vesicular colloid cysts. The gland is an adenoid goitre from a case of primary Graves' disease.

thyroid into thymus tissue. As the vessels run down the neck they form the so-called thyro-thymic ligament of Piersol (*Fig.* 326), or they may continue as discrete vessels ending in the mediastinal thymus. As we demonstrated in previous publications,[13, 15] besides ending in the mediastinum these lymph channels also end in nodes of thymus tissue situated in the hilum and beyond the upper pole of each thyroid lobe. The proof that such lymphoid nodes in the neck are thymus depends upon finding Hassall corpuscles in the tissue.

Pathological material also provides a proof of the course taken by these special lymphatics of the thyroid. The material suitable for this purpose can be taken either (1) from cystic conditions of the thyroid found, for example,

FIG. 328.—The intrathyroid lymph spaces. The three drawings illustrate the same lymph space (shown in the centre of A and C; below and to the right of the centre of B) sectioned at different levels. In A a blood capillary is seen within the space, demonstrating that the space cannot be a 'catarrhal' thyroid follicle. The other sections (B and C) show an intense proliferation of the endothelium, which is ultimately desquamated into the lumen as shown in A.

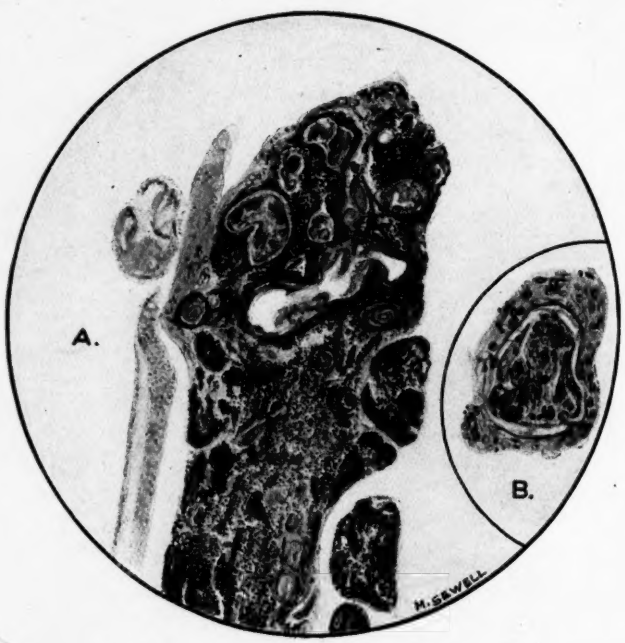



FIG. 329.—A, Drawing of thymus from the same case as *Fig.* 328, showing cystic dilatation of the thymic portion of the thyro-thymic lymph channels; B, Details of proliferated endothelial wall of a dilated thymic channel. The section illustrates the identity of the thymic channels with those of the thyroid, and further shows that the same functional activity engages both parts of the thyro-thymic lymph system simultaneously.

in Graves' disease or lymphadenoid goitre,[16] or (2) from malignant disease of the thyroid.

Primary cysts* of the thyroid are of two kinds: the familiar encysted vesicles distended with colloid, and lymphatic cysts lined with endothelium (*Fig.* 327). It is with the latter only that we are here concerned. Cystic conditions of the lymphatics permit us to trace the course of the trapped

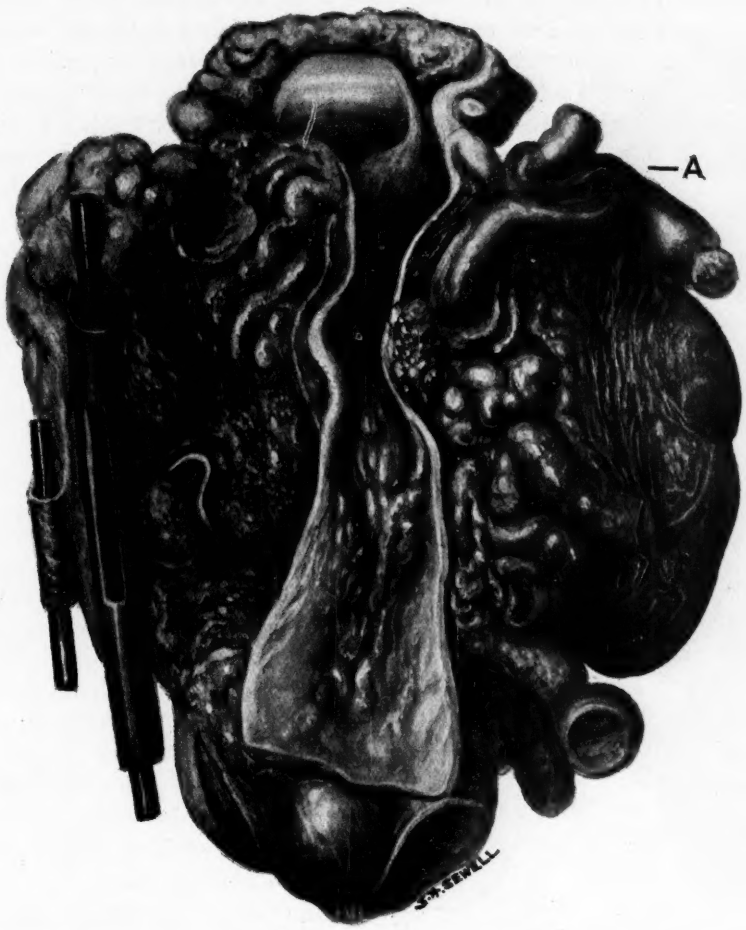


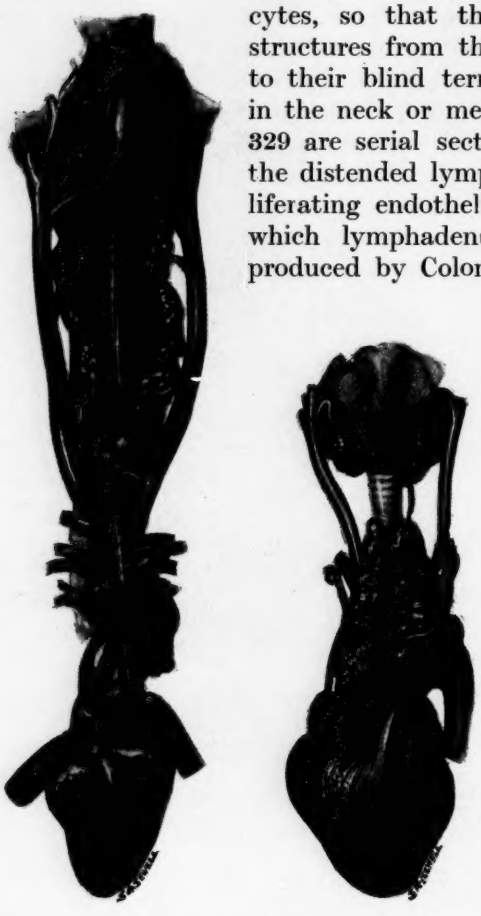

FIG. 330.—Posterior view of a thyroid gland removed post mortem. The right lobe is occupied by a proliferating cancer. The lymphatics emerging from the hilum of each thyroid lobe are distended with cancerous growth. Note that they pass up the neck as well as down towards the mediastinum. A, Lymphatics; B, Left inferior thyroid artery; C, Right superior thyroid artery; both these vessels are patent. (*R.C.S. Museum.*)

lymph. The dilated channels may begin in distended sinusoids, pass to the hilum of the lobe, and thence travel down *and up* the neck. But in every case they end blindly in thymic tissue. Again, that these nodes in which they terminate are thymus is determined by the presence of Hassall corpuscles.

* Secondary cysts are those due to hæmorrhage or to colliquative necrosis.

Distended channels of this order are encountered in the fœtus, in childhood, in Graves' disease, and in old age (*see Fig.* 326).

The most striking example of dilatation of the thyro-thymic lymph channels occurs in lymphadenoid goitre,[16] both in the natural disease and in the experimental conditions in rats.[17] Here, moreover, the whole of the special lymph tract is not only dilated but also in a state of pronounced functional activity. In this condition the special lymph channels are filled with proliferated *endothelial cells* as well as lymph and lymphocytes, so that they can be traced as very striking structures from the thyroid lymph sinusoids (*Fig.* 328) to their blind termination in thymus tissue anywhere in the neck or mediastinum (*Fig.* 329). *Figs.* 328 and 329 are serial sections of thyroid and thymus to show the distended lymph spaces filled with lymph and proliferating endothelium. The sections are from a rat in which lymphadenoid goitre has been experimentally produced by Colonel McCarrison.[17]



FIGS. 331, 332.—Drawing of specimens attributed to Sir Astley Cooper, who injected the thyroid gland in a successful attempt to infiltrate the thymus and its 'absorbent vessels' with mercury. *Fig.* 331, Probably in young calf. *Fig.* 332, Human infant. (*R.C.S. Museum.*)

Malignant disease of the thyroid often presents a beautiful natural injection of this special lymph system. The growth can at times be followed in continuity from its origin in thyroid epithelium within a lymph sinusoid, along the interstitial lymph channels to the hilum of the lobe, and thence *up as well as down* the neck into thymus tissue (*Fig.* 330). Again the criterion which determines that the lymphoid tissue is thymus is the presence of the Hassall corpuscles (Tebbutt and Woodhill[18]).

Thus we see that both natural injection and pathological distension of the thyroid lymph spaces allow us to trace a special lymphatic system common to the thyroid and thymus. We learn from these specimens that thymic tissue is distributed over an area extending from the base of the skull to the pericardium—that, in fact, the thymus is a neck as well as a mediastinal organ. As far as we can see there seems to be no connection between this thyro-thymic lymph system and the cervical lymph glands. *The thyro-thymic lymph system seems to be a closed system.*

Now in a previous paper[13] we recalled the fact that the discovery of the thyro-thymic lymphatic channels was due to Sir Astley Cooper,[19] who described

them in 1832. He injected the thyroid lymph spaces from the thymus. We have failed to find any valves in these lymph channels—so that no conclusions may be drawn from his procedure as to the natural direction of flow in this system. In the living, however, the spread of some forms of cancer seems to indicate that the open course of flow is from the thyroid to the thymus tissue. Recently Sir Arthur Keith has found in the Royal College of Surgeons injection specimens of thyroid and thymus attributed to Sir Astley Cooper (*Figs.* 331, 332). These specimens show that experimental injection of the thyro-thymic lymph channels fully confirms the conclusions drawn from the other and more natural sources.

We must conclude therefore that in mammals the thyroid and thymus are directly connected through a common lymphatic system. What, then, we must ask, is the essential structure and nature of the thymus ?

## STRUCTURE OF THE THYMUS.

The thymus is composed of lymph tissue*, though it has not the nature of a lymph gland. According to the current description given, it is a mediastinal organ composed of lobules set in series along a coiled fibrous strand (*Fig.* 333). If, however, we go back to the work of earlier investigators, we find that they held somewhat different views. In 1845 Simon[20] published his results of a detailed study of the anatomy and comparative anatomy of the organ. He demonstrated that in birds and mammals the thymus was a neck organ. He knew it to be distributed in a particular fascial plane immediately ventral to the great vessels of the neck and extending from the base of the skull to the pericardium. In mammals the bulk of the organ lay anywhere in the region *above or below, or intermixed with the thyroid gland.*

FIG. 333.—Diagram to show the construction of the thymus. The lobules are described as clustered about a connecting fibrous cord. We have since shown that the fibrous cord is made up of a leash of lymphatic channels. (*After Sappey—Quain's 'Anatomy.'*)

Simon, moreover, held that the bulk of the gland was composed of a series of fine much-plicated tubes. He showed that the wall of each tube was composed of endothelium. In the wall, or in the saccules off the wall, occurred lymphocytic aggregations or lymph nodes (*Fig.* 334). Now Simon knew that the lymphocytes were *dynamic* and not static features; they come

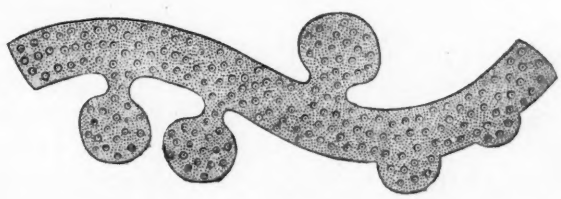


FIG. 334.—Diagram to show the formation of the plicated thymic tube in the wall of which are set the thymic follicles. (*Simon.*)

* Leaving aside the Hassall corpuscles, with which we are not at present concerned.

and go under functional stress. This transient nature also belongs to the fat which may replace the lymphocytes, as he showed in his study of hibernating animals. In this connection we must stress the fact that it is these functional and dynamic features, i.e., lymphocytes and fat,* rather than the anatomical structure of the thymus, which do not persist in the mediastinum with age. The lymph channels, which are the essential structural feature of the thymus, persist throughout life. The thymus as a tubular lymphatic organ remains. With age its function alone changes, and this only quantitatively, for it can be shown that if the nodes of thymus in the human neck are examined, even the lymphocytic function persists to some degree throughout life in most bodies. If, therefore, we are to understand the nature of the thymus we must cease to look for aggregates of lymphocytes as a proof of its existence, for these are but a functional feature of its endothelium.

The body of the thymus gland, then, is made up of an aggregation of much-plicated endothelial lymph tubes in the walls of which lymph nodes may or may not be present. The lymph tubes are themselves the blind terminals of the special thyroid lymphatics. Thus the thymus is essentially a *lymph reservoir*; and we can but conjecture that this reservoir is for the storage of some product of thyroid activity. *The thyroid and thymus are thus not two organs, but different parts of the same organ.* This is a very important conclusion for anatomy, but we have still to determine whether the association of these structures is an acquired peculiarity of mammals or a fundamental arrangement found in all vertebrates. If it is as fundamental as it appears, then it will be fully represented in both the embryology and comparative anatomy of the two organs. If the association is a special feature acquired late in the evolutionary process, then again it is important to determine the particular point at which it was acquired. It is along such lines of inquiry that we may hope to find a clue to the function of the two organs.

## EMBRYOLOGY AND COMPARATIVE ANATOMY.

The thyro-thymic lymph system as a whole is divided naturally into two parts, that which lies within the thyroid and that portion which lies beyond the gland. We propose henceforth to speak of these two as the *intra-thyroidal* portion and the *extra-thyroidal* portion of the thyro-thymic lymph system.

### EMBRYOLOGY.

In the embryo the thyroid first appears as a groove or dimpling at the site of the foramen cæcum in the floor of the buccopharynx. Even before the groove appears the site of origin can be identified readily by an accumulation of chromophil substance in the epiblast. The primary epiblastic groove deepens and a bud appears growing down into the underlying mesoblast. The bud itself is composed of both epiblast and mesoblast. The head of the growing bud increases in size as it moves tailwards through the mesoblast, so that it soon appears as a pear-like mass attached by a long stalk to the

* We ought to add endothelial proliferation as an additional functional factor appearing at times in the thymus. The large endothelial cells fill with lipoidal matter.

region of the foramen cæcum. The mass or body of the gland at this stage is closely invested by the surrounding fibroblastic tissue (*Fig.* 335*a*).

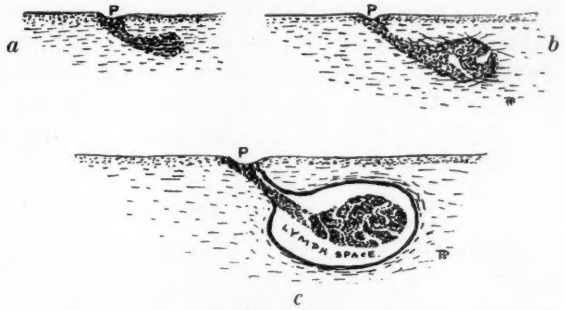



FIG. 335.—Diagrammatic representation of stages in the early development of the thyroid lymph system. *a*, Thyroid bud growing from a groove in the floor of the pharynx (P), formed of both 'epiblast' and 'mesoblast' and at first a compact mass; *b*, The appearance of spaces in the bud breaking up the epithelium into partially discrete masses; *c*, Fusion of these spaces at the periphery of the bud resulting in the formation of one large cavernous space enclosing the whole gland.

Next there appears within the pear-shaped body of the gland a series of spaces* which break up the mass into a collection of units (*Fig.* 335*b*). These spaces we interpret as the precursors of the intra-thyroidal lymph system, and we believe that they will be found to arise from the contained mesoblastic element in the thyroid bud. As development proceeds, the spaces extend to the periphery of the mass. Here they fuse, forming a continuous space separating the primitive gland from the surrounding fibroblastic tissue. The newly formed anatomical feature is thus a large cavernous space in which the thyroid is suspended (*Fig.* 335*c*).

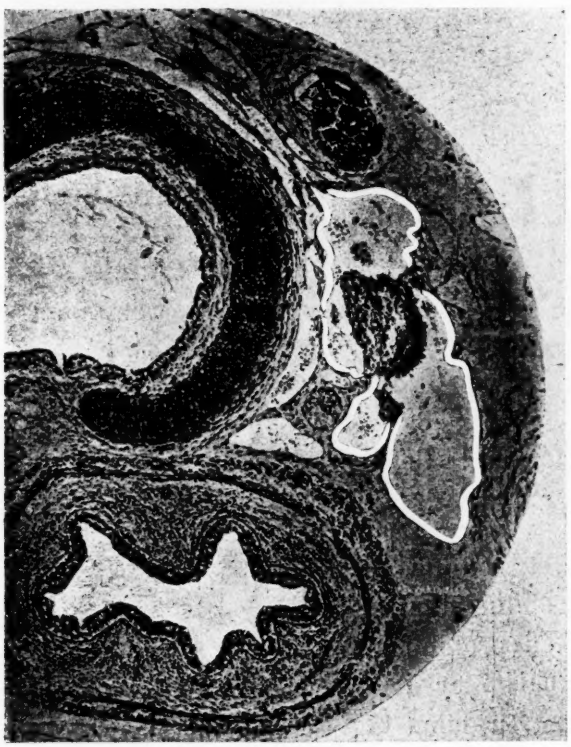


FIG. 336.—Photograph of a section of a human embryo showing the thyroid lying within an extensive lymph space (outlined in white). (*After Bérard and Dunet.*)

Thus the human thyroid gland at the 60-mm. stage of the embryo can be described as a stalked organ floating in a large lymph space. The stalk is the thyroglossal duct. The space surrounding the gland extends up to the floor of the mouth. The blood-vessels to the gland cross the space from the side. The figure showing this stage (*Fig.* 336) is taken from Bérard

* Norris,[21] who first described this early development of the thyroid, carefully points out that the spaces which form at this early date are not thyroid follicles. The follicles appear at a later stage of development.

and Dunet.[22] It must be carefully noted that the region in the embryo in which this development occurs extends from the hyoid arch through the whole gill-arch area. The gill arches originally abut on the lateral surfaces of the lymph space in which the thyroid is suspended. Embryology clearly indicates the importance of the thyroid lymph space, and emphasizes the fact that there develop simultaneously an intra-thyroidal and an extra-thyroidal portion.

The next question we must ask is whether the progress of evolutionary development also bears out the foregoing facts.

### COMPARATIVE ANATOMY.

The thyroid system of the full-grown dogfish consists of a large cavernous sac in which floats a pear-shaped thyroid gland attached by a stalk of epithelium to the floor of the buccopharynx at the foramen cæcum (*Fig.* 337).

FIG. 337.—Drawing of a dissection of the thyroid of the adult dogfish showing the gland floating in a cavernous lymph sinus.

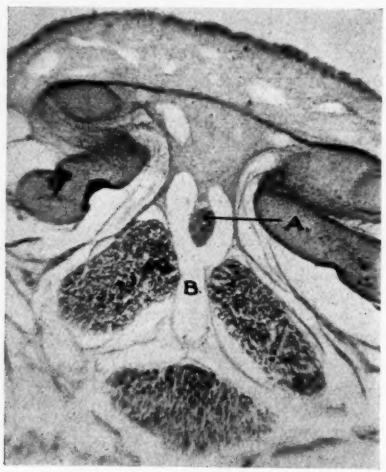
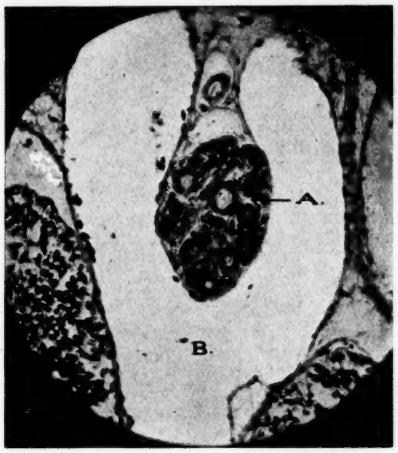
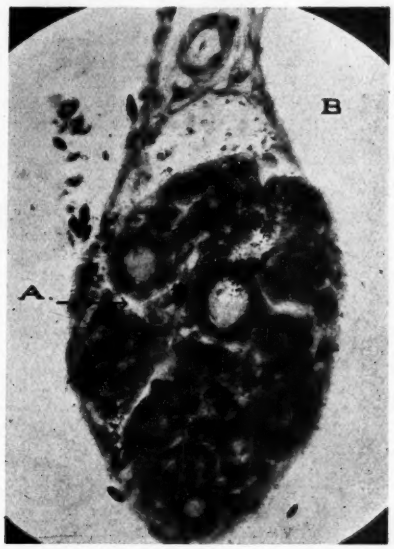



FIG. 338.—Cross-section of the buccopharyngeal region of a young free-swimming dogfish (2·8 cm.) showing the thyroid gland (A) floating within the extra-thyroidal cavernous lymph space (B). Compare this section with the human fœtal gland shown by Bérard and Dunet (*Fig.* 336).

The gland floating in the lymph is anchored by its stalk and by the two lateral thyroid arteries which cross the cavity from each side. The thyroid system of the mature dogfish is thus identical with the thyroid system of the 60-mm. human embryo in its general arrangement. Nor, indeed, do the details differ. The body of the dogfish thyroid is composed of columns of follicles separated by spaces—the *intra-thyroidal* lymph system—which communicate directly with the large extra-thyroidal cavernous lymph system (*Figs.* 338, 339, 340). The intra-thyroidal spaces can be filled with injection mass which thereupon passes directly into the cavernous space. Agreement between phylogeny and ontogeny is thus complete in so far as the essential relation of the thyroid epithelium to the lymph spaces is concerned. A special thyroid lymph system is apparently a fundamental feature of vertebrates.

But comparative anatomy carries the matter still further, because it indicates the relation of the thyroid to other structures. There are two very special features of the extra-thyroidal lymph-sac of the dogfish to be noted. The first is that the caudal part of the thyroid lymph-sac is attached to the pericardium by a fibrous cord. The proximal portion of the cord is hollow. It represents a caudal extension of the cavity of the thyroid lymph-sac towards the heart; the significance of this we shall see later. The second important point to note is the source of the tributaries to this thyroid lymph-sac. The lymph-sac drains the floor of the bucco-pharynx through many small tributaries. But the *two main tributaries come from the gills* on either side. These tributaries are essentially lymphatic, though it is usual to find in them a few red blood-corpuscles, because, even at this stage in evolution, there is still a fairly free communication between veins and lymphatics, as Burne[23] has demonstrated. In the dogfish the lymph channels are but a recent evolution from the veins.




FIGS. 339 and 340.—High-power microphotographs of *Fig.* 338, showing A, the peri-follicular intra-thyroidal lymph spaces of the compact thyroid body, which is suspended within a large extra-thyroidal lymph-sac, B.

Thus the thyroid lymph-sac in the dogfish is formed of a central cavity and two main extensions of the sac draining the gills. We could thus describe the whole thyroid lymph space as a *thyroid-gill lymph system* receiving the subsidiary tributaries from the floor of the mouth. There must be some functional importance to be attached to this arrangement.

For further light on the problem we must turn to a still more primitive thyroid system, namely that of the angler fish (*Lophius piscatorius*).[23] In this fish the thyroid system is even less organized. It consists of a central cavernous lymph-sac to the inner wall of which are attached columns of naked thyroid epithelium.* Into this sac open two main tributaries from the gills as in the dogfish (*Figs.* 341, 342).

* *See* BRITISH JOURNAL OF SURGERY, 1926, xiii, No. 51, p. 469, *Figs.* 287–289.

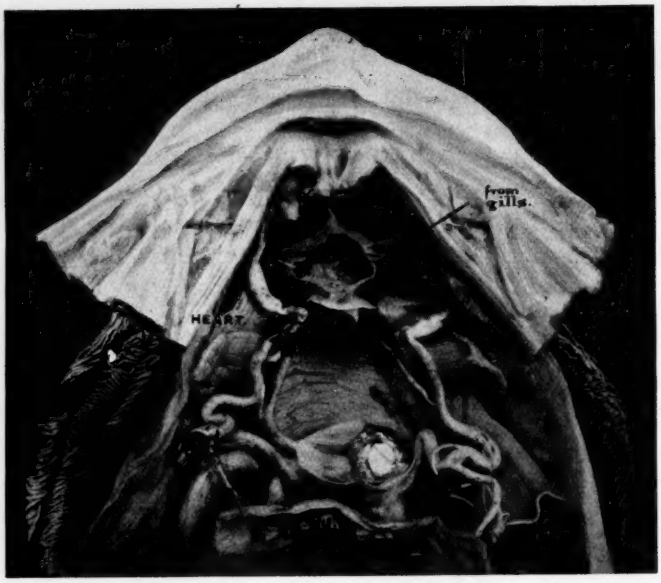



FIG. 341.—Photograph of a dissection of thyroid of *Lophius piscatorius* showing the thyroid lymph-sac with its tributaries from the gills and connections with the heart vessels. The ventral surface of this sac has been removed to show the reticulations of the inner wall which bear the thyroid follicles. (*After Burne.*)

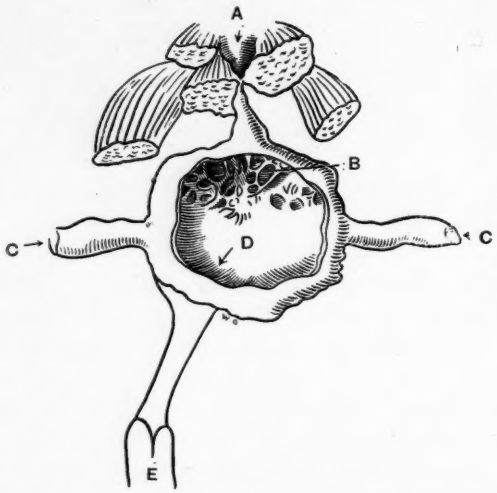



FIG. 342.—The connection of the thyroid and its lymph-sac with the gills and heart. A, Floor of mouth; B, Reticulations bearing thyroid follicles; C, From gills; D, To heart; E, Inferior jugular vein. (*After Burne.*)

**Origin of the Intra-thyroidal Lymph Spaces.**—In the angler fish the thyroid epithelium is not gathered together to form a compact gland. Solitary columns of follicles are scattered over the inner surface of the central sac. The epithelial columns float freely in the lymph-sac anchored to its wall by their vascular supply—in other words, the intra-thyroidal and the extra-thyroidal lymph systems are here one and the same. The columns of thyroid follicles have not yet been aggregated or bunched together to form a compact mass, thereby separating off a system of perifollicular spaces from the large extra-thyroidal lymph space, as in the dogfish and man (*Fig.* 343 A, B). The

origin of the intra-thyroidal lymph system as seen in dogfish and man has been traced. The arrangement in man is but a modification of the simple cavernous type of thyroid lymph system found in the most primitive specimen. The most important fact is that wherever found the *thyroid epithelium is bathed directly by lymph.*

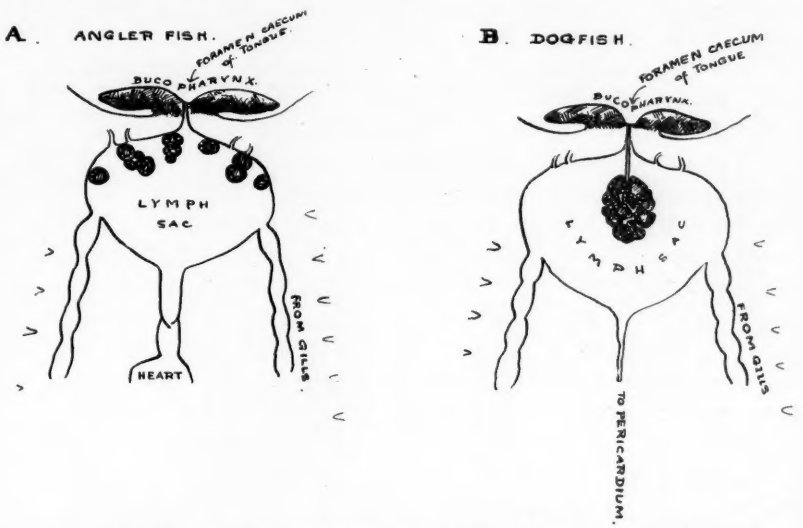



FIG. 343.—Diagram to illustrate the essential relationships of thyroid epithelium to the lymph and the principal area drained by the special thyroid lymph system. The central space of the lymph system is occupied by *naked* thyroid epithelium, in the angler fish (A) attached to the wall of the sac, in the dogfish (B) clustered about a central stalk. The main tributaries draining into the lymph space are from the gills on either side. Subsidiary tributaries flow into the space from the mucous membrane of the buccopharyngeal cavity. In the dogfish the lymph space appears to be a cul-de-sac, whereas in the angler fish the lymph space opens freely into the heart through the inferior jugular vein. A relic of this channel is represented in the dogfish by the partially hollow fibrous cord attaching the sac to the pericardium.

**The Origin of the Thyroid Lymph System as a Whole.**—There is yet another feature of this more primitive thyroid-gill lymph system which must be stressed. We have seen that in the dogfish the central thyroid lymph-sac is attached to the pericardium by a partially hollow fibrous cord (*Fig.* 343 B). In the more primitive angler fish this caudal extension of the central sac is joined to the inferior jugular vein and so is in direct communication with the heart cavity (*Fig.* 343 A). This vessel is valved so that the flow of the thyroid-gill lymph is towards the heart (*Fig.* 342). The two main tributaries from the gills are thus brought into direct connection with the heart. Originally they must have been two large lateral sinuses subtending the gills. They occupy, in fact, the position of the ventral venous sinuses found in the larval forms of fish, e.g., ammocetes. We may therefore conclude that the thyroid-gill lymph space was originally part of the venous blood system.

**Relation of the Thyroid-gill Lymph System to the Thyro-thymic Lymphatics.**—Now, the thyroid-gill lymph system in fish is bilobed. It lies immediately ventral to the great vessels and the buccopharynx. It extends through the hyoid region over the whole gill-bearing area. Centrally it runs from the base of the tongue to the heart. The position of this thyroid-gill lymph

system in fish is, in fact, that occupied by the thyroid lymph-sac in the human embryo. But in fish in which a cavernous lymph-sac is present no thymus has been conclusively identified.* This is to be expected, for there are not as yet any lymph glands and the purification of the lymph does not excite lymphocytosis in fish. In birds and mammals we have already seen that the thymus is a lymph organ occupied by the plicated lymphatic vessels of the extra-thyroidal lymph system. We have, moreover, seen that the thyroid apparatus in man, including the thyro-thymic lymphatics and the thymus, lies in a specific fascial plane, and that the thyroid lymph-sac in fish occupies precisely the same fascial plane. The anatomical relations of the two are identical. For the thymus, therefore, to become part representative in man of the thyroid-gill lymph-sac of fish, there only is left to explain the translation of a saccular cavernous space into a series of tubular capillary spaces. This is precisely what does happen in the evolution of all vascular channels, whether arterial, venous, or lymphatic. They begin primitively as irregular cavernous spaces, and, under the pressure of the conformation of surrounding structures and because of the need of a more specific directional flow of the contained fluids, are transformed into tubular structures. We may infer, therefore, from comparative anatomy and embryology that the thyro-thymic lymph system of mammals is derived from a thyroid-gill lymph system found in fish.†

The thyro-thymic lymph system is a fundamental part of the thyroid apparatus which is preserved with modifications throughout the vertebrate kingdom. It has its origin in the vascular system of the gills of the primitive vertebrate.

The thyroid lymph system must play an important part in the physiology of the thyroid apparatus. In fish the thyroid hangs suspended in a lymph vascular system emptying into the heart. We must draw attention to the analogy between the thyroid epithelium bathed by the returning lymph from the gills *en route* to the heart, and the liver epithelium bathed by the returning blood from the intestine *en route* to the heart. We began with an analogy between the thyroid and liver and end with an even more significant analogy between the same two organs. The gill membranes and the buccopharyngeal membranes, from which the thyroid lymph is derived in fish, are in direct contact with the watery environment, and so with any substance, oxygen, salts, etc., dissolved therein. The thyroid epithelium is in a position to act on the lymph from the gills in the same way as the liver epithelium acts on absorbed material from the gut. In man the gills have disappeared, but the original gill-lymph space remains as the thyro-thymic lymph system to fulfil some function which was once included in the general respiratory function in fish. Perhaps herein lies a clue to the function of the thyroid apparatus as a whole in man.

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* The organ of Stannius in fish has frequently been considered as the representative of the thymus. Its structure, however, is that of a tonsil; it is not related serially to the gills or gill clefts; it has no relation to the great vessels; it does not lie in the ventral fascial plane, and is far removed from the thyroid.

† We are not concerned at this point with the evolution of the Hassall corpuscles and other formed structures in the human thymus, but with the plicated lymphatic spaces which form the main bulk of the organ.

## CONCLUSIONS.

The foregoing facts make it clear that not only are the thyroid and thymus an integral part of one apparatus, but that the thyro-thymic lymph system is pivotal in the functioning of both organs. What light does this throw on the physiology of the thyroid ?

Now the histologist has always insisted that the elimination of some thyroid secretion takes place via the lymphatic pathways of the gland. The physiologist, however, up to the present has found no proof of this by experiment because he has been content to accept iodine, and iodo-colloid alone as evidence of thyroid activity. The histologist agrees with the physiologist *that the passage of 'iodo-colloid' and iodine through the gland never implicates the lymphatics*. We ourselves have studied colloid both entering and leaving the follicles, but under neither circumstance have we ever found it cause any change in the appearance of the lymph sinusoids in the thyroid or of the lymphatic channels of the thymus.[8*] Nor does the thymus contain iodine or thyroxin. Recent studies of the iodine values of the blood entering and leaving the thyroid respectively lend support to the contention that iodo-colloid leaves the gland through the blood-stream.[24, 25] Furthermore, Carlson and Woelfel,[26] and more recently Hicks,[27] have shown that iodo-colloid does not leave the thyroid along the lymphatics of the capsule. Nor does it enter the lymph glands of the neck. In fact all the available evidence, both positive and negative, indicates that colloid is eliminated by way of the blood channels. Nevertheless the histologist still insists that *some product* of thyroid activity is eliminated by the lymph pathway—for example, Bondi,[2] Hürthle,[3] Langendorff,[28] and Launoy.[29]

What, then, we must ask, is the product of cellular activity of the thyroid —clearly a secretion†—which histologists constantly have observed inciting a reaction in the lymphatic channels ?

We have shown that this secretion is the misnamed 'secretion of hyperplasia' with which the physiologist, pathologist, and surgeon alike are so familiar. This secretion is not only histologically different from iodo-colloid,[8] but neither is its chemical nor is its biological action that of iodo-colloid.[30] The two secretions are in fact distinct entities ; they are neither similar nor derivative.[31] This other secretion can be seen traversing the epithelium from the lumen of the follicle to enter the perifollicular lymph spaces, and, as we have already seen, can be followed from thence into the thymus.[13] On reaching thymic tissue it stimulates the endothelium of the lymph spaces to

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* In a recent publication on the subject (Orr and Leitch, "Iodine in Nutrition", *M.R.C. Reports*, 123, 1929) we are erroneously quoted as holding precisely the reverse opinion.

† We use the term 'secretion' in this paper in the generally accepted sense meaning any material accumulating within the thyroid follicle. In this sense colloid is a secretion. In our earlier histological studies we restricted the term 'secretion' to the substance which accumulates in the follicles as a result of an activity of the thyroid epithelium identical with that described as the 'secretory' process in other glands such as the pancreas or submaxillary—namely, accumulation of granules, liquefaction of the protoplasm, vacuolation, etc. In this latter sense colloid is not a secretion. It accumulates within the follicle without any visible change in the physical condition of the epithelial protoplasm or the nuclei.

produce lymphocytes. Under certain normal conditions this secretion may even stimulate the endothelium of the thyroid lymph sinusoids or the interstitial lymph channels of the thyroid to emulate thymus, producing thereby a characteristic aggregation of lymphocytes in the thyroid. In other words, *this secretion can stimulate the production of lymphocytes throughout the thyro-thymic lymph tract.* The secretion is, in fact, a lymphogenic substance, which iodo-colloid (thyroxin) is not. For these and other reasons we must in future speak of this secretion in contradistinction to the iodo-colloid as the *lymphogenic secretion* of the thyroid. The two thyroid secretions can no longer be confused: they are iodo-colloid secretion and lymphogenic secretion.

The surgeon is very familiar with the lymphogenic secretion—for, as we have said above, it is the secretion of 'hyperplasia' found in goitre. The term 'secretion of hyperplasia' is unfortunate, for this 'hyperplasia', as Marine and most other workers have shown, is a *normal* procedure. The Continental workers* have always avoided this confusion, for they speak of the so-called pure hyperplastic goitre as 'struma parenchymatosa'. Further, when both lymphogenic function and colloid function are involved they speak of 'struma parenchymatosa et colloides', and when lymphogenic function is entirely in abeyance they speak of 'struma colloides'. They have three clear pictures of the possible combinations of these two functions in goitre. Struma parenchymatosa diffusa is the adenoid goitre,† not, as used to be taught in England, the colloid goitre. If in future we speak of 'lymphogenic hypertrophy',‡ 'lymphogenic + colloid (or mixed) hypertrophy', and 'colloid hypertrophy' severally, we shall avoid much confusion in discussing goitre. It might be asked why we should not adopt the Continental terminology. The reason is obvious; both secretions are indeed 'parenchymatous' in the proper sense of the word, for they are both held within the parenchyma of the gland.

We have shown elsewhere[31] that lymphogenic secretion is responsible for the toxic state in Graves' disease and toxic goitre—in fact, for all forms of thyrotoxicosis. Lymphogenic secretion is Plummer's 'poor substance', to which he has assigned a definite group of toxic symptoms in Graves' disease.[33] Now in our experience every case of thyrotoxicosis coming to post-mortem examination is suffering from status thymico-lymphaticus.§ This is also the general experience on the Continent and in America. Indeed, Graves' disease has been called toxic status thymico-lymphaticus.[29, 34] The facts set forth in this study give a reason for the association of these conditions. Status lymphaticus is an essential part of the *overaction* of the lymphogenic function of the

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* *See*, for example, de Quervain[32] and *Report of International Conference on Goitre, Berne*, 1927.

† A gland in which the whole tissue is occupied in producing lymphogenic secretion to the exclusion of iodo-colloid storage. (*See* Williamson and Pearse.[16])

‡ By hyper*trophy* we imply an increase in the functional activity of an organ. If this hypertrophy is maintained by the growth of new cells to meet the demand, then a hyper*plasia* will appear.

§ Since Graves' disease and toxic goitre occur in adults the status thymico-lymphaticus cannot be confused with the problematic conditions thus described in this country as the cause of sudden death in children.

thyroid. The excess of lymphogenic secretion is stored in the thymus. We may consider this physiological procedure as indicating that the lymphogenic secretion after it leaves the follicles is in itself (and normally) toxic, and that it has to be detoxicated by the endothelium giving rise thereby to local lymphocytosis.* When the surgeon by amputation removes the excess of lymphogenic secretion in the thyroid, he relieves the toxicosis : indeed, that is the only conclusive test for thyrotoxicosis. Furthermore, some surgeons[35-37] have treated cases with success by operating on the thymus.† The explanation of the success of either of these procedures arises out of the facts set forth in this paper. Obviously it is a more certain procedure to attack the seat of manufacture of the lymphogenic secretion in the thyroid rather than its thymic storehouse. Thymectomy can never be looked upon as the better procedure.

Our studies also explain another fact. Bircher has succeeded in producing Graves' disease experimentally in dogs. He implanted into the peritoneum thymus tissue from cases of Graves' disease, and status thymico-lymphaticus and Graves' disease—the full syndrome (exophthalmos, goitre, and tachycardia)—resulted from his procedure.[38] Now the normal lymphoid thymus represents *only the detoxicated secretion* ; its administration, therefore, does not cause Graves' disease experimentally. Nor, we have found, does the lymphogenic secretion *while it is in the follicles* of the thyroid produce Graves' disease when given to animals. The lymphogenic secretion must, in fact, be caught in transit *from* the thyroid to the thymus if it is to be used successfully in producing experimental Graves' disease. Hence success followed Bircher's use of the *semi-cystic* thymus from Graves' disease and status thymico-lymphaticus. *We are forced to the conclusion that thyrotoxicosis would seem to be due to a failure of the lymphatic endothelium of thymus and thyroid to effect the natural detoxication of the lymphogenic secretion produced by the thyroid.*

While dealing with the subject of status lymphaticus as an essential part of thyrotoxicosis we would make a suggestion. It is probable that the degree of status thymico-lymphaticus present in any patient is an index of the risk of death during operative procedures ; we refer especially to sudden death. This matter is still one of importance, for the risk at operation has not disappeared with the use of iodine prophylaxis. The thymus cannot be inspected clinically nor can its degree of enlargement be satisfactorily determined ; it is, then, desirable to find some means of gauging the severity of the condition in the patient.

Now the studies presented in this paper show that the thyro-thymic lymph space surrounds the thyroglossal duct. It is not surprising therefore to find that accompanying thymic enlargement in thyrotoxicosis there is a corresponding enlargement of the lymphatic tissue in the posterior third of the tongue —the 'thyroid trigone' of the tongue as it might well be called. Now this area can be inspected, and it may thus afford the clinician a convenient means of estimating the degree of status thymico-lymphaticus present in any case

* A similar procedure happens in lymph glands behind a septic focus.

† Halsted has collected 500 cases of thymectomy for Graves' disease.[36]

of thyrotoxicosis or Graves' disease (*Fig.* 344). Further, the thymic lymph space may still retain some of its connections with the buccopharyngeal lymphatics apparent in fish; so that, to rid the patient of enlarged tonsils and remove septic foci from this region would seem to be a necessary procedure, as experience has demonstrated.

FIG. 344.—Photograph of the 'thyroid trigone' of the tongue in a case of Graves' disease, showing the hypertrophy of the lymphatic tissue of this area which accompanies the status thymico-lymphaticus present in this disease.

We may now look at another aspect of Graves' disease on which these researches may have some bearing — namely, tachycardia, which is a cardinal symptom of the disease. We have seen that the thyroid lymph system is part of the main *gill-vascular circuit* in some fish, and that it opens directly into the heart. This direct connection is lost in man, but clinical experience proves that the association between the thyroid and the heart is far from being lost. Without going into details in this paper it can be said that in the primitive fish and its vertebrate ancestor the thyroid and vascular system are also associated through a *special nerve-arc* of very peculiar nature which links the thyroid epithelium to the muscles of the gill-venous lymph system.[39] There is reason to suppose that this thyroid-vascular nerve-arc is also present in man, but we must reserve consideration of this fact for a later paper.

There are other lymphatic conditions of surgical interest which may possibly be explained by our studies of the thyro-thymic lymph system. We refer to the cystic hygromas.[40-44] The probability is considerable that the cystic hygromas are due to developmental abnormalities of the thyro-thymic lymph tract. These swellings are known to be endothelial-lined cysts, and are peculiar in that their walls are constantly found to contain both fat and lymphocytes. In this respect their form and function recall forcibly the description given by Simon of the nature of the thymic lymph spaces in animals.[20] Furthermore, in the human embryo at a certain stage in development the thyro-thymic lymph system is a large cystic cavity pervading the structures of the neck. The sites from which these tumours grow, where they have been discerned, as in small tumours or early stages of cystic distension, coincide closely with the position of the thyro-thymic lymph tract. The fact that they should become grossly cystic and invade more distant parts, such as the shoulder muscles, is to be expected, therefore, if they develop within a closed thyro-thymic lymph system.

There is a further point which is noteworthy in this connection. We refer to the fact that, according to the recorded history of many cases of cystic hygromas, the swellings tend to manifest themselves, or on the other hand to enlarge, shortly after birth, and again at or about puberty. Now these are periods of enhanced lymphogenic activity of the thyroid gland, and as we

have seen above it is the lymphogenic activity of the thyroid which induces a lymph flow in the thyro-thymic tract. Increase in the size of the hygromas at these periods would therefore be what we should expect were they thyro-thymic lymphatic formations. Clearly the lymphatic hygromas need reviewing in the light of this new knowledge.

Lastly, we must return to the subject of the thyroid lymphatics in their relation to thyroid cancer. The fact that there are two distinct systems of lymphatics emerging from the thyroid gland—(1) the 'lymphæ comites' of the veins, i.e., lymphatics of the capsule, and (2) the thyro-thymic lymph system (*see Fig.* 325)—leads us to scrutinize closely the thyroid neoplasms. Theory suggests the division of these neoplasms into: (1) Those which primarily invade the deep cervical glands of the neck and in this way resemble the cancers of adjacent organs, e.g., œsophageal cancer; and (2) Those which primarily invade the thymus. In clinical experience this theory is not without support. Every surgeon dealing with the thyroid knows that some thyroid cancers, true to type, invade the lymph glands—the deep cervical group. But the other thyroid neoplasms, which are of the greater number, are atypical in their history, sequence, and spread. Again, the frequency with which certain thyroid growths invade the mediastinum without involving the adjacent deep cervical glands at all is very well recognized.[45, 46] In view, however, of the anatomy of the specific thyro-thymic lymph tract which we demonstrate in this paper, this seeming peculiarity of the direction of the spread of thyroid cancer is precisely what we should expect to find. Any proliferating growth of the thyroid epithelium may fill the lymph sinusoids and extend naturally along the thyro-thymic lymphatic channels into the thymic lymph reservoir. Furthermore, the extensive distribution of some cancers into positions anywhere in the neck from the base of the skull to the mediastinum is also explained, for we must expect invasion of thymus tissue wherever it lies, and as we have shown, the thymus is a neck organ as well as a mediastinal one. (*See also* Tebbutt and Woodhill.[18])

Now if the thyroid and thymus are functionally but one apparatus as phylogeny and ontogeny insistently indicate, any growth confined within the specific thyro-thymic lymph system is still a *growth confined within the organ of its origin.* In this sense such a growth cannot rightfully be classified from the pathologist's point of view as a true malignant neoplasm; it must rather be called a hyperplasia. Possibly the anomalous names used to describe certain of the thyroid tumours foreshadow this fact. We refer, for example, to designations such as 'aberrant thyroid tumour', 'metastasizing adenoma', 'benign metastatic', 'benign recurrent adenoma', and 'wuchernde struma'. This type of growth, tending as it does to spread widely in the neck and to fill the mediastinum with a large solid mass of new growth, appears considerably more malignant either than it is or than its subsequent course usually indicates. When finally it becomes diffuse it does so by direct invasion rather than by any lymph metastasis.[46] Indeed, rupture into blood-vessels with blood transportation seems to be the dissemination stage of this neoplasm.* Secondary tumours formed in this way from tissue emboli reproduce *in toto*

* *See* the classical case of von Eiselsberg.[47]

the form of the organ of their origin, and, moreover, show a functional potentiality unusual for metastases. These 'implants' can function as thyroid gland. They present a marked contrast to the metastases of veritable carcinomata—cellular seeds—which multiply into cancers that do not exhibit any functional power. These thyroid emboli are really 'organomata', resembling closely certain suprarenal tumours which spread in a similar way and exercise a similar functional power.

The surgeon naturally sees greater possibilities for cure in the eradication of any growth that is confined to the organ of its origin, and he is prepared to go to great lengths in surgical procedure so long as *cellular metastases* are not a feature of the neoplasm. Operation on thyroid neoplasms of the order which we have been describing should only be delimited by topographical difficulties due to the situation of the thymus. Perhaps the newer procedures —radium, etc.—may render this neoplasm more accessible.

Owing to the importance of this subject we propose to deal fully with thyroid cancers as a whole in a subsequent publication.

## SUMMARY.

1. A special thyro-thymic lymph system is described as the essential and most primitive feature of thyroid anatomy.

2. The intra-thyroidal portion of this system consists of thyroid lymph sinusoids draining into intralobular lymphatics. These lymphatics, unlike those of the capsule of the thyroid, emerge from the substance of the gland at the *hilum* of each lobe.

3. The extra-thyroidal portion of this system consists of lymphatic channels proceeding from the hilum of the thyroid lobe to their termination in thymic tissue.

4. Thymic tissue occupies both neck and mediastinum, thymic nodes being liable to occur anywhere within a special deep fascial compartment of the neck extending from the base of the skull to the pericardium.

5. Structurally all thymic tissue is formed of the coiled plicated capillary terminals of the thyro-thymic lymphatics.

6. The thymus is thus essentially of the nature of a lymph reservoir to the thyroid gland.

7. A special secretion of the thyroid, which we have called *lymphogenic secretion*, is poured into the thyroid lymph sinusoids, and can, under appropriate conditions, be seen pervading the whole thyro-thymic lymph system.

8. The anatomical facts set out above are confirmed by embryological and phylogenetic studies of the thyroid apparatus.

9. In the most primitive thyroid known the naked epithelial follicles lie in a cavernous lymph-sac.

10. In the course of phylogenetic development this primitive lymph reservoir becomes the thymus of man.

11. In the primitive form the thyroid lymph reservoir receives its main tributaries from the gills.

12. In the primitive form the thyroid lymph reservoir drains, by a valved opening, directly into the heart.

13. Thus, the primitive thyroid lies in the effluent lymph coming from the gills and pharynx on its way to the heart, just as the liver lies in the effluent blood coming from the gut *en route* to the heart.

## CLINICAL INFERENCES.

1. The thyroid and thymus must be regarded as one apparatus in all considerations of the thyroid function. Especially must this apply to the study of Graves' disease, thyrotoxicosis, and endemic goitre.

2. The lymphogenic secretion of the thyroid (which elsewhere we have shown to be responsible for thyrotoxicosis) is normally detoxicated in the thyro-thymic lymph channels. This explains the constant association of Graves' disease and thyrotoxicosis with status thymico-lymphaticus. It also explains the claims made for thymectomy in the treatment of thyrotoxicosis.

3. A reason is provided from comparative anatomy for the cardiac implications in thyrotoxicosis.

4. The thyro-thymic lymph system is a closed system, It has no connection with the cervical lymphatic glands into which the 'lymphæ comites' of the capsular veins of the thyroid drain.

5. Thyroid cancers may be divided into two main groups: (*a*) Those primarily invading the capsular lymphatics and extending to the deep and superficial cervical glands; and (*b*) Those primarily invading the thyro-thymic lymph system and extending into the thymus.

6. Thyroid cancer occupying the thyro-thymic lymph channels may appear in the neck or mediastinum, since this is the area over which thymic tissue is normally distributed. Under such circumstances the growth is still confined *within the organ of its origin* and is still capable of function. Such intrathymic nodules are not to be classified, *qua* malignancy, in the same category as the 'cellular seeds' of true metastases found in the ordinary lymph glands.

7. Certain features of the cystic hygromas of the neck suggest that these tumours have origin in developmental abnormalities of the thyro-thymic lymph system.

We have again to thank Sir Arthur Keith, Sir James Berry, Professor George Gask, and Mr. T. P. Dunhill for material, criticism, and help in the preparation of this work, which was done on behalf of the Medical Research Council.

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# *SHORT NOTES OF RARE OR OBSCURE CASES*

## GIGANTIC BENIGN TUMOUR OF KIDNEY WEIGHING 22 POUNDS. NEPHRECTOMY: CURE.

By G. GORDON-TAYLOR,
HON. SURGEON TO THE MIDDLESEX HOSPITAL, LONDON.

The rarity of benign tumours of the kidney presenting features of clinical interest, together with the enormous size of this particular neoplasm, appear to justify the publication of this case on the eighth anniversary of the operation for its removal.

History.—Olive B., an unmarried lady of 20 years, was referred to me with the diagnosis of an intra-abdominal tumour. For four years she had noticed a gradual distension of her abdomen, but during the three months which immediately preceded her consultation with me in June, 1921, the enlargement had increased at a much more rapid rate. The menstrual history was normal, there were no changes in the breasts, and no mention was made of any digestive disturbances other than might readily be occasioned by the presence inside the belly of a mass of such dimensions as this tumour was found at operation to possess. The patient confessed a feeling of increasing lassitude, but her great complaint was of the inconvenience produced by the growing distension of her abdomen, which hampered freedom of movement, interfered with her games, and by imparting such amplitude and rotundity to her figure taxed to the utmost the skill and the art of the *couturière*.

On Examination.—The abdomen was enlarged, and there could be felt a large tumour occupying the greater part of the belly; it extended upwards under the left costal arch and downwards into the left iliac fossa and the hypogastrium. The mass did not move on respiration, nor could it be displaced by manipulation through the abdominal wall. The uterus was pushed downwards by the weight and volume of the tumour, from which it could not be separated with any certainty on rectal examination. There were no abnormalities in the urine, but unfortunately no cystoscopic, radiographic, or pyelographic investigations were carried out. An exploration of the abdomen was clearly indicated and was performed in June, 1921.

Operation.—Under gas and open ether anæsthesia a left paramedian incision of generous length revealed the existence of a huge retroperitoneal tumour, over which coursed numerous large and dilated veins. The diagnosis of a retroperitoneal sarcoma suggested itself, but nevertheless there appeared to be possibilities of a successful extirpation of the mass. No difficulties of

exceptional character attended the liberation and delivery of the tumour; but it was only at the very last stage of the operation, when the neoplasm remained still attached to its bed by a relatively slender pedicle, that this latter was recognized as containing ureter and renal vessels. The left kidney seemed lost in the mass, which now came to be regarded as a malignant renal neoplasm. The right kidney was rapidly palpated, and the left-sided tumour was thereafter speedily freed and removed. The abdominal wall was closed and the patient returned to bed in fair condition after her severe operation.

Post-operative convalescence proved almost uneventful: the girl subsequently married, and is now the mother of three children. Her health

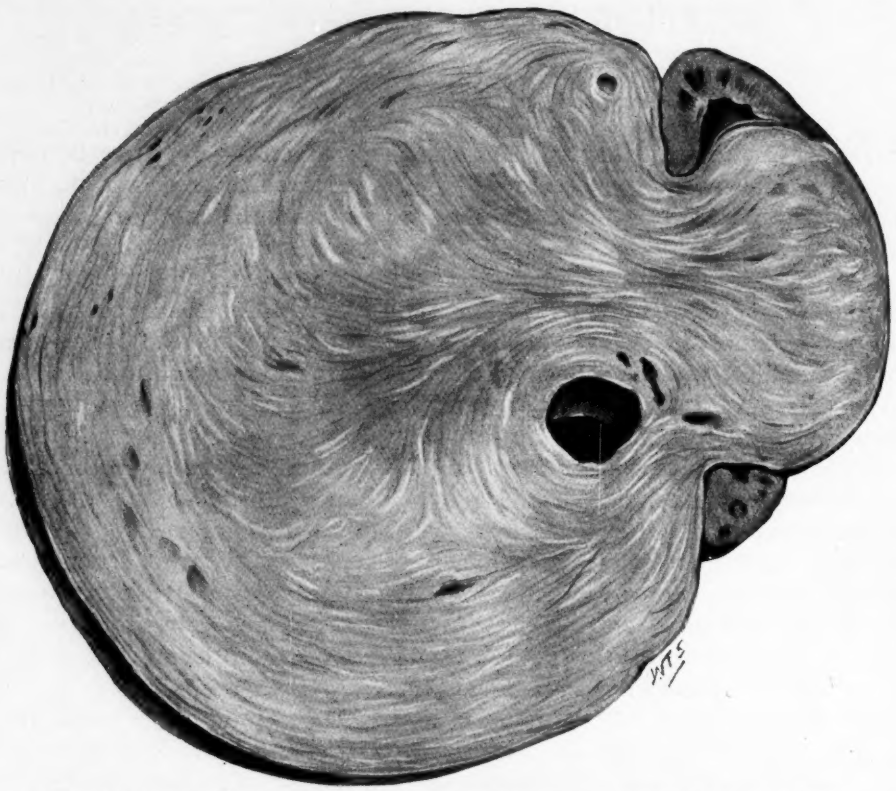

FIG. 345.—Adenofibroma of left kidney; nephrectomy; lips of hilum of kidney widely separated, permitting the escape of the tumour.

has been excellent since her operation, and it is now the eighth anniversary of the date on which she was freed from the weight and inconvenience of her huge encumbrance.

PATHOLOGICAL REPORT.—The tumour at the time of its removal weighed 22 lb., and the following report upon its naked-eye and microscopic character has been furnished me by Dr. S. L. Baker, of the Bland-Sutton Institute, Middlesex Hospital:—

**The tumour appears to be an adenofibroma of the kidney of embryonic origin.**

***Macroscopically.*—A firm rounded tumour measuring 13 by 11 by 5 in. At one end of the mass is seen the kidney, of which the poles only are intact, the remainder**

being thinned out over the tumour surface. The tumour has the appearance of having grown from the region of the renal pelvis. The mass has a well-defined capsule, and the cut surface shows a whorled appearance and appears to consist of firm, fibrous tissue. In the region of the kidney are a collection of cysts ranging from a few millimetres up to 1½ in. diameter, the lining of which is studded with rounded papillary projections.

*Microscopically.*—The tumour shows a somewhat loosely arranged fibrous stroma, scattered about in which are fairly numerous tubules lined by cubical or rounded cells. There are also cysts lined by flattened epithelial cells. The general appearance suggests a fairly slow-growing benign tumour.

The appearances presented in *Fig.* 345 strongly suggest that the tumour originated in the vicinity of the renal sinus, as is remarked by Dr. Baker in

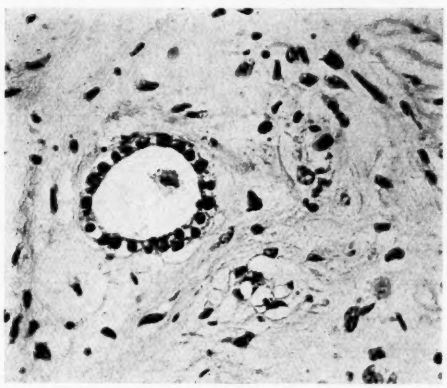

FIG. 346.—Microphotograph exhibiting a tubule which resembles those of adult type.

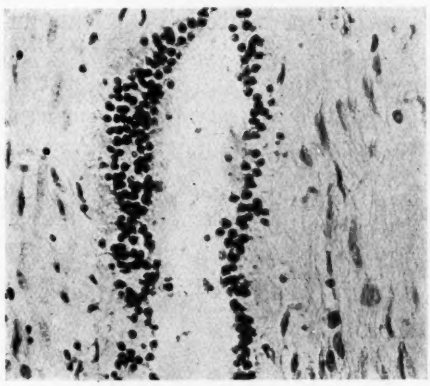

FIG. 347.—Microphotograph exhibiting a tubule of embryonic type.

his pathological report upon the specimen, and that growing externally it expanded and thinned out the kidney over itself. On the mesial aspect of the kidney the lips of the hilum can be seen widely separated to permit the escape of the tumour, which has undergone an exaggerated development on the concave aspect of the organ.

The histology, which exhibits tubules resembling those of adult type (*Fig.* 346) as well as several of embryonic character (*Fig.* 347), renders it difficult to label the tumour and its place of origin with absolute pathological exactitude; the admixture of different epithelial forms in the mass of fibrous tissue which constitutes the great bulk of the tumour (*Fig.* 348) is consistent with an origin from Wolffian remains in the vicinity of the hilum, but it must be borne in mind that congenital anomalies are also met with in the kidney itself. In the latter "the existence of a variety

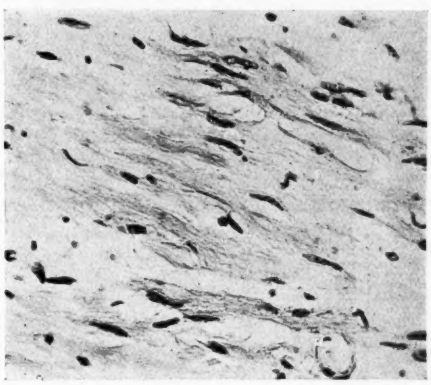

FIG. 348.—Microphotograph showing the fibrous tissue of which the main mass of the tumour is formed.

of structural defects is fully attested " (Ewing[1]), and it is unnecessary to go further afield than a consideration of the subject of adrenal 'rests' to find evidence of aberrant embryology in connection with the kidney.

Benign growths of the kidney are infrequent, and rarely present themselves as tumours for diagnosis. Renal fibromata are but seldom problems for the clinician, but in Bruntzell's[2] patient a fibroma is recorded which weighed as much as 20 lb., and Sir Henry Morris[3] refers to a case where a fibroma growing within the renal capsule attained a size approximating to that of a child's head. No record of an adenoma of the kidney of surpassing size has been exhumed from the literature. The tumour here reported would appear to be the *largest benign tumour of the kidney on record.*

It is noteworthy that benign renal neoplasms never attain the enormous dimensions presented by perinephric tumours, which constitute some of the very largest growths known to pathologists and surgeons. The perinephric tumours which have reached the most colossal size are the lipomata, which may be pure or may contain an admixture of tissues; the perinephric fibromata are less frequent, and never attain the huge weight exhibited by the largest lipomata.

The largest perinephric tumour appears to be that reported by Hirsch and Wells; this was explored, found to be inoperable, and at the autopsy weighed 69 lb. The following are the *largest perinephric tumours* arranged in the order of their weight:—

| | | |
|---|---|---|
| Hirsch and Wells | 69 | lb. |
| Billroth (reported by Salzer[4]) | 63·8 | ,, |
| Waldeyer[5] | 63 | ,, |
| Homans | 57 | ,, |
| Vogelwied[6] | 55 | ,, |
| Cantoni[7] | 55 | ,, |
| Demoulins | 53 | ,, |
| Windle[8] | 50 | ,, |

The specimens of Waldeyer and of Windle both came under notice as post-mortem trophies and contained a sarcomatous element. Many of the others recorded in the above list died as the result of surgical adventure.

The points of interest about the adenofibroma of the kidney reported in this communication are: (1) The huge weight of this benign renal tumour; and (2) The good health of the patient eight years after the removal of the mass, the subsequent clinical history and the microscopic findings fortunately reversing the pessimistic opinion as to the nature of the tumour entertained and expressed at the time of the operation, when it was regarded as malignant in character.

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# CASE OF RECURRENT DUODENAL ULCER AFTER PYLORECTOMY, AND THE FORMATION OF BONE IN A LAPAROTOMY WOUND.

By W. B. FIDDIAN-GREEN,

HOUSE SURGEON TO THE SURGICAL UNIT, ST. MARY'S HOSPITAL, LONDON.

C. L., male, age 44, was admitted to St. Mary's Hospital on March 11, 1924.

History.—In 1917, while in the Army, the patient had recurrent attacks of epigastric pain and vomiting; these occurred usually some hours after food, and the pain was relieved by the vomiting. Between the attacks he had intervals when he was entirely free from pain. As the pain was increasing in severity and frequency and he was losing weight, he came to hospital for treatment. He presented no physical signs on examination, but a radiograph after a barium meal revealed an ulcer in the region of the pylorus.

First Operation.—He was operated on under general anæsthesia by Professor C. A. Pannett on March 13, 1924. Numerous adhesions were found about the pylorus, and an ulcer of the first part of the duodenum penetrating the pancreas. An excision of the ulcer-bearing segment of the duodenum and a small part of the antrum of the stomach was performed, followed by a Billroth I operation. Convalescence was uneventful, and the patient was discharged on April 3.

Fig. 349.—Radiograph showing the ulcer in the upper part of the duodenum.

Reports of his condition were obtained in March, 1925, and in February, 1927. He had been free from pain and discomfort except on one occasion after a large meal of red meat and cheese. During this period he had existed on a liberal diet.

On May 27, 1929, the patient was readmitted to hospital with the following history. He had had no symptoms until February, 1929, when he had a recurrence of his former attacks of pain and vomiting which lasted fourteen days. He had a further period of attacks early in May. On admission he was free from pain. X-ray examination after a barium meal showed evidence of an ulcer situated in the upper part of the duodenum. The radiograph reproduced (*Fig.* 349) shows this very well.

Second Operation.—An operation was performed under spinal anæsthesia by Professor Pannett on June 3. An ulcer of the posterior wall of the duodenum, adherent to the pancreas and surrounded by a mass of induration,

was found. Owing to the adhesions it was possible only to do an anterior gastrojejunostomy. No evidence of the original suture line could be detected.

**Comments.**—The interesting feature of this case is that for five years after the first operation the patient had experienced no symptoms whatever. This operation was performed at a time when it was not realized that the essential factor in the treatment of duodenal ulcer by excision is to remove a sufficiently large portion of the antrum of the stomach. Removal of too small an amount of the antrum is believed to be the explanation of the recurrence of the ulcer in the case recorded above. This view is supported by the observations of H. Jansen.[1] He collected from the literature on the subject 21 cases of recurrent ulcers after Billroth I (these are true recurrent ulcers and not peptic ulcers, which may follow Billroth II). Of these, 11 were suture recurrences and 10 were away from the gastroduodenal junction. In nearly all these there is sufficient explanation in the small resection of antrum carried out. In a few cases other predisposing factors, such as the use of silk thread, were concerned; and others were ulcers which had been overlooked and may therefore be termed 'false ulcers'. Jansen states that there are two reactions essentially concerned in the neutralization of the gastric juice in the duodenum: (1) The reflux of the alkaline secretions into the stomach, which is controlled by the pylorus; and (2) The reflex inhibition of the gastric secretion caused by the presence of acid in the duodenum and jejunum. Of these the latter is by far the more important. Following this explanation, the operation most correct physiologically is Billroth I, with large resection of the antrum. After this operation the antrum, the excitor of the chemical secretory phase in the stomach, is removed and only psychic secretion remains. The inhibitory reflexes from the duodenum come into play unweakened and even strengthened, because the stomach chyme goes unchecked through the gastroduodenal opening, there being no sphincter. Furthermore, reflux takes place more freely.

A second interesting feature of this case is that about a month after the patient's first discharge from hospital he noticed the scar of his laparotomy wound had become indurated. It gradually became harder, and led to some discomfort when he bent forward. When he presented himself for examination in May, 1929, a hard cartilaginous-like area could be felt directly under and adherent to the scar. It was not attached to the xiphisternum or costal cartilages. At the second operation this indurated mass was found to be osseous, and to consist of two parts joined in their middle thirds and so arranged that one half was in front of and the other behind the inner border of the right rectus muscle. It formed, in fact, a gutter in which lay the inner border of the muscle. The piece of bone, of which a drawing is reproduced here (*Fig.* 350), was 9 cm. long. It was removed and part sectioned for microscopic examinations; the pathologist's report stated that it was true osseous tissue.

Sir Arthur Keith,[2] in a survey of the literature, records 36 cases of the formation of bone in laparotomy wounds, 34 of which occurred in wounds in or near the supra-umbilical part of the linea alba. In the case here reported the incision was a right paramedian, the rectus sheath being divided and reflected off the muscle. The piece of bone was densely adherent to the sheath

near the linea alba. This formation of bone in wounds is explained by the theory that certain cells of the body other than those of the skeletal system, under certain circumstances, are able to take on osteoblastic function. The fact that in so large a proportion of the cases recorded the growth of bone

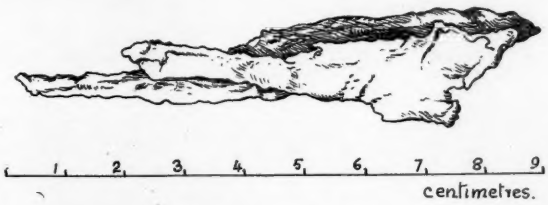


FIG. 350.—Osseous indurated mass that formed at the site of the laparotomy scar.

has taken place in the epigastric region, leads to the suggestion that cartilage cells set free by injury to some part of the costal cartilage may, under these circumstances, be able to take on bone-forming properties. In the specimen obtained in this case the thickest part of the bone was that nearest the costal margin, and here it would seem the growth of bone started.

My thanks are due to Professor Pannett for permission to publish this case, for the drawing produced, and for his assistance.

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## A CASE OF ANOMALOUS KIDNEY PRODUCING SYMPTOMS.

BY R. K. DEBENHAM,
SURGICAL FIRST ASSISTANT AT THE LONDON HOSPITAL.

ANOMALIES of the kidney itself may occur alone, but are more often found in connection with other anomalies of the urinary tract; thus a kidney abnormal in form is often abnormal in position and is associated with abnormal vessels. Of the 38 anomalies of the kidney studied by Braasch,[1] 3 were ectopic kidneys. The frequency of ectopic kidney is shown by Naumann,[2] who in a collected series of 10,177 autopsies found 20 cases of this condition. Of these, 12 were on the left, 5 on the right, and 3 bilateral. The condition is more common in women than in men; Sträter[3] found that in 66 cases, 53 occurred in women and 13 in men.

The frequency of multiple renal arteries is shown by Brewer (cited from Seldowitsch), who found more than one renal artery on one side in 85 (56 per cent) of 151 cadavers. Of these, there were 70 which showed two renal arteries, 12 showed three, 2 showed four, and 1 showed five. Seldowitsch[4] found 43 cases of supernumerary renal arteries in 150 cadavers (30 per cent).

In 33 cases the supernumerary arteries were unilateral, in 10 bilateral. Anomalous renal arteries are the rule in anomalous kidneys, fusion forms, ectopic kidneys, etc. Ectopic kidneys only infrequently give rise to symptoms unless associated with other disease.[5] The case of anomalous kidney that is reported below produced symptoms at the age of 33, and was associated with hydronephrosis. Of 98 cases of unilateral single supravesical obstruction causing hydronephrosis, 3 were due to ectopic kidney and 1 to nephroptosis with aberrant vessels (Brady Institute cases[5]).

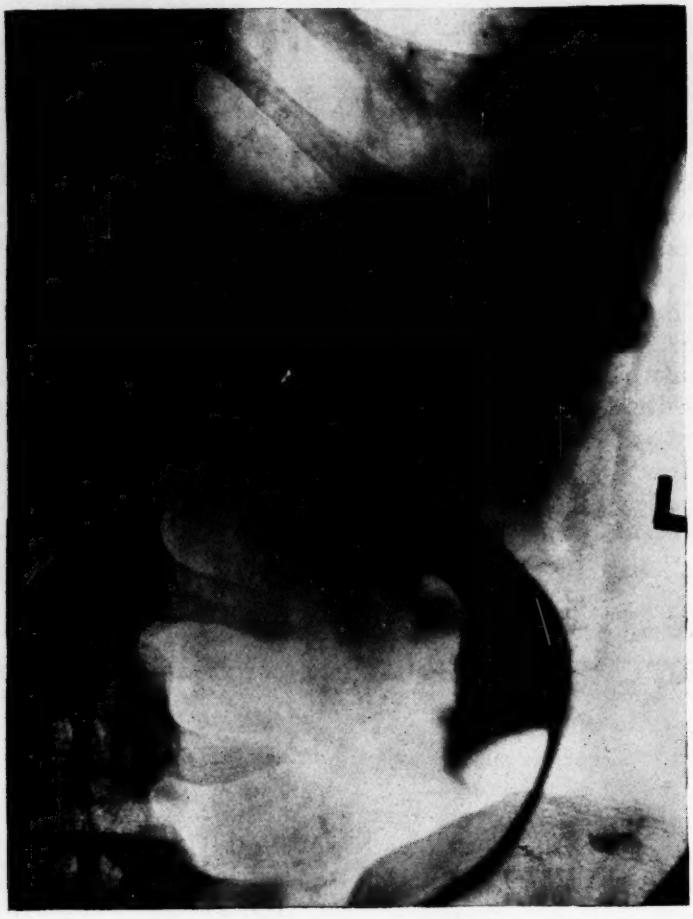
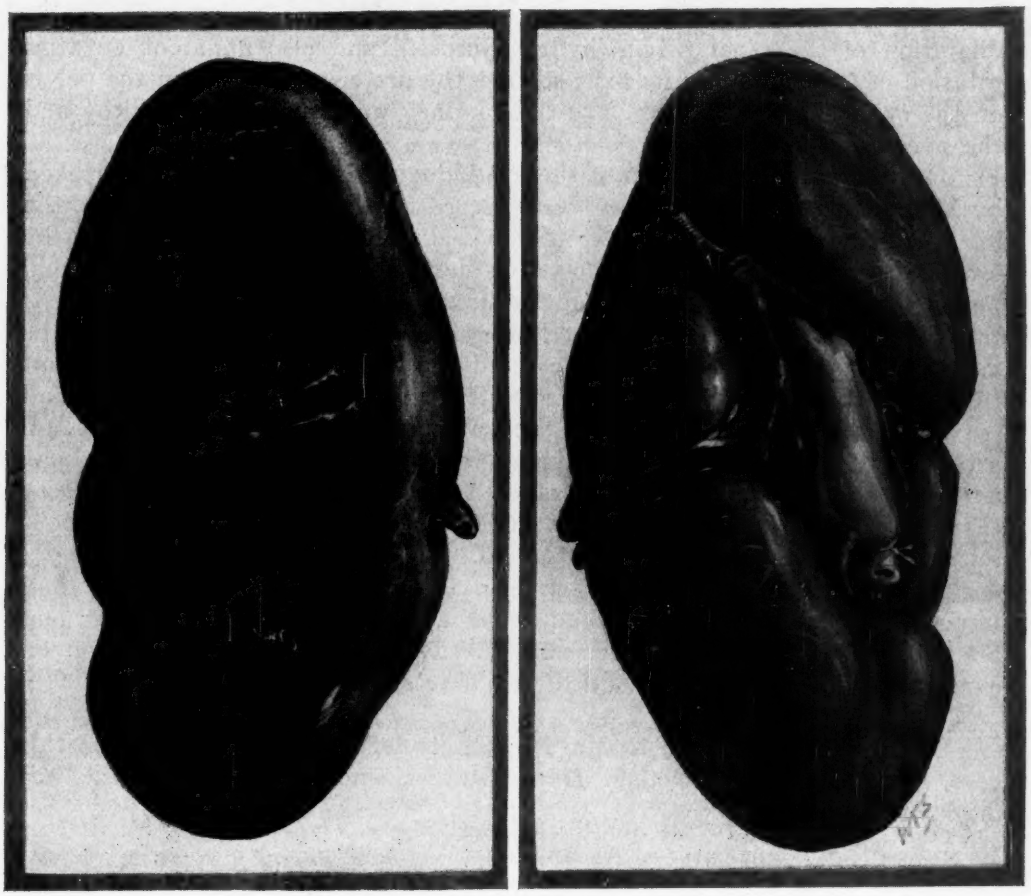



FIG. 351.—Pyelogram of left kidney.

The following case is reported as showing a very rare congenital condition of one kidney. The diagnosis lay between carcinoma of the colon and a renal swelling, a pyelogram being invaluable in deciding the question.

HISTORY.—The patient, a male, age 34, complained of pain in the left lumbar region, together with frequency of micturition, the symptoms being of nine months' duration. The pain was in the left lumbar region, and at a corresponding point in the front of the abdomen, extending forwards almost to the mid-line in the umbilical region and occasionally radiating down to the

left groin and testicle. It was a constant dull pain, with occasional severe exacerbations. There was increased frequency of micturition, twice at night and every hour or two by day. There was never any hæmaturia, the bowels were regular, and the previous health had been good, though there was a history of having passed bright red blood per rectum off and on for twelve months, ten years previously.



Posterior View. Anterior View.

Fig. 352.—Showing the condition of the kidney. It was of approximately normal size. The pelvis emerged from the anterior surface of the kidney and was considerably dilated, the ureter arising from the outer side of the pelvis.

On Examination.—The patient was a healthy, well-nourished Hebrew. In the left lumbar region there was a well-marked, easily palpable, smooth, firm swelling, extending slightly backwards into the loin; it was lower than a normal kidney, the examining finger could be placed above the swelling, between it and the left costal margin; the swelling was easily movable and not tender. The right kidney was not enlarged, and there was nothing abnormal on rectal examination.

The urine had a specific gravity of 1020, was clear, acid, with a slight

cloud of albumin, and showed leucocytes and epithelial cells on microscopical examination of the deposit.

An X-ray examination of the urinary tract was negative, the right kidney being normal in size. A barium enema showed no abnormality in the colon.

On cystoscopy the bladder and ureteric orifices were normal. A pyelogram of the left kidney was taken, 15 c.c. of sodium bromide being injected into the left kidney pelvis, when the patient experienced pain to the left of the mid-line in the umbilical region. The pyelogram showed considerable dilatation of the renal pelvis (hydronephrosis), and also apparent outward rotation of the kidney on its axis, so that the ureter emerged from the pelvis on the outer side (*Fig.* 351). The right kidney was found to be healthy and the pyelogram normal.

Operation.—Exploration of the left kidney was advised and undertaken by Mr. Hugh Lett. The kidney was exposed by the usual lumbar route, the incision being made rather lower than usual. The organ was found to be low, and partly in the left iliac fossa, the left suprarenal being in the normal position. *Fig.* 352 shows the condition present.

The main renal vein left the kidney at the hilum, which was on the anterior surface. A small artery entered the hilum at the upper part, but the main arterial supply entered the posterior surface of the kidney, one and possibly two vessels coming from the left common iliac artery. One small artery with a large vein passed behind the posterior surface of the kidney, curved round the outer side, and entered the hilum on its external aspect; these vessels appeared at the operation to be constricting the kidney about its centre. Nephrectomy was performed.

Subsequent Progress.—When seen two months later the patient had lost all his symptoms; he had had no pain, had gained 8 lb. in weight, and his frequency of micturition was normal. There was no lump to be felt on examination, and he has remained well ever since.

I am greatly indebted to Mr. Hugh Lett for allowing me to report this case, and also to Dr. Donald Hunter under whose care the patient was originally admitted.

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# *REVIEWS AND NOTICES OF BOOKS.*

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**Lehrbuch der diagnostischen und operativen Cystoskopie.** By Dr. EUGEN JOSEPH, of Berlin. Second edition. Royal 8vo. Pp. 254 + vii, with 290 illustrations, some in colour. 1929. Berlin: Julius Springer. Paper covers, RM. 48; bound, RM. 51.

THOSE who have read Dr. Joseph's book *Die Harnorgane im Röntgenbild* will know that he is an enthusiastic urologist, deeply interested in the developments of pyelography, and an excellent writer; they will look forward to reading this new edition of his work on cystoscopy, and they will not be disappointed. The first edition of the present work was brought out in 1923, and was then called *Kystoskopische Technik*; during the intervening period the author has devoted himself more especially to improving the technique of operative cystoscopy, and has accordingly modified the title of his book.

In the 254 clearly printed pages of this text-book, the surgeon and the urologist will find an excellent account of the technique of cystoscopy, of the various conditions of the bladder revealed by this instrument, of the author's method of making pyelograms, and of his opinions on the estimation of kidney function. In the last fifty pages will be found an account of the latest developments of operative cystoscopy—the fulguration treatment of bladder tumours, the crushing of vesical stones under the control of the (cystoscopic) eye, and various endovesical procedures in disease of the prostate and of the bladder neck. The illustrations are numerous, good, and to the point; they include a number of clearly reproduced pyelograms and some very helpful diagrams. The author gives a short and lucid sketch of the optical mechanism of the cystoscope, and points out that it is not necessary to go more deeply into the science of optics, "since a U-boat can be navigated without a knowledge of the optics of the periscope".

Whilst the reader will find few startling novelties in this work, it can probably be taken as an expression of the teaching of the modern German school of urology, and it may be of interest to compare some points of the author's practice with those prevailing in this country. Under the still vexed question of anæsthesia, we note that Dr. Joseph hardly ever uses a general anæsthetic for cystoscopy; he considers that it interferes with the function of the kidneys and invalidates the findings of the various methods of estimating their efficiency. He never employs cocaine for urethral and bladder anæsthesia, for he once saw, as an assistant, a death which was undoubtedly due to this drug; he thinks that alypin is the safest and most reliable anæsthetic for this region, though he appears to have lived through one or two alarming experiences even with this. He states that sacral anæsthesia is less toxic but also less certain than spinal; it can be easily carried out in thin patients, but is often impossible and uncertain in the adipose. Although he does not approve of taking pyelograms in the out-patient clinic, he has frequently had to do so owing to the shortage of beds, and he has not seen any serious sequelæ.

Of the appearances described as seen by the cystoscope, by far the most interesting is what he calls 'Schramm's phenomenon'; as this has not yet crept into the English text-books, we will give a short résumé of his remarks on this subject. This phenomenon is described under the heading of the trabeculated bladder, and it consists in the possibility of seeing, with a cystoscope of average calibre, certain details of the prostatic urethra, such as the verumontanum, the openings of the prostatic and ejaculatory ducts, etc. When this phenomenon is present it is an almost certain sign of disease of the central nervous system; its absence, however, does not

preclude the existence of such disease. As a proof of its reliability, the author quotes the case of a man whom he cystoscoped some time after the fulguration of a papilloma of the bladder; there was no sign of the tumour, but Schramm's phenomenon was noticed quite accidentally; the patient was sent on to a neurologist, who reported that he was suffering from locomotor ataxy with characteristic loss of tendon reflexes. As this seems to be still another of the pre-ataxic signs of this disease, the observation would well deserve following up.

Under the heading of the estimation of kidney function, the most striking fact brought out is that Rehn, in answer to a questionnaire as to the relative frequency of the various tests used in German clinics, found that chromocystoscopy not only heads the list but is employed almost twice as often as any other test; the two next in frequency are cryoscopy and the water and concentration methods.

In view of the opinions expressed by recent English writers as to the causation of hydronephrosis, it is quite refreshing to find that Dr. Joseph is a firm believer in the old theory that movable kidneys and abnormal renal arteries are real and potent causes of this condition; he gives some convincing pyelograms in support of this. He is quite enthusiastic on the subject of the crushing of vesical stones under the control of the cystoscopic eye, and he says that this procedure is not only extraordinarily safe but is not particularly unpleasant for the patient.

We can recommend this book for a place in the library of urologists and of those surgeons who are interested in cystoscopy.

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**The Preparation of Catgut for Surgical Use.** By W. Bulloch, L. H. Lampitt, and J. H. Bushill. Special Report Series, No. 138. Medical Research Council of the Privy Council. Royal 8vo. Pp. 178, illustrated, 1929. London: H.M.S.O. 4s. net.

The value of the researches described in this publication can be estimated by recognizing their direct bearing upon the practice of surgery, and by considering how many may benefit by the investigation. To those who have a living interest in the craft of surgery the mere title of the Report, associated with the name of William Bulloch, is sufficient to indicate its fundamental importance, and a sufficient stimulus to study its pronouncements with care. To those who feel they have already attained perfection the observation that the vast majority of catgut ligatures sold as sterile in the open market proved to be infected when examined bacteriologically must come as a disquieting thought. To the whole profession and to the public, it will be reassuring to learn that surgical catgut is to be controlled under the Therapeutic Substances Act, the data of this Report having been directly useful in the guidance of administrative action.

As the Council points out in the Preface, the work stands in historical succession to the classical studies of Lister. In addition, however, to the description of a prodigious amount of experimental work upon the bacteriology and physical properties of catgut, the Report contains the most complete modern account of the history and literature of the whole subject. An investigation of this magnitude demands painstaking study, and the authors deserve our gratitude for the clarity with which they have formulated their conclusions.

The first part, by Professor Bulloch, deals with disinfection; the second, by Dr. L. H. Lampitt and Mr. J. H. Bushill, of the Research Laboratories of Messrs. J. Lyons and Co., describes the physical and chemical properties of sheep's intestine and the effects upon them of iodine sterilization.

Commencing with an extremely interesting historical survey of the use of catgut in surgery, Professor Bulloch records that after being employed in ancient times it fell into disuse, to be reintroduced in 1816 by P. S. Physick, of Philadelphia, who was at one time House Surgeon to John Hunter. Lister's contributions to the subject, extending over forty years in the latter part of the last and the beginning of the present century, may, however, be considered as inaugurating the modern period. A synopsis is given of the observations upon disinfection made by Lister and his contemporaries, and of the perplexities and discrepancies which they encountered in their investigations. The historical review ends with the 'iodine period', introduced by Claudius in 1902.

A description is given of the anatomy of the sheep's intestine, and of the processes it passes through in the production of catgut; and it is pointed out that if catgut intended for surgical use were prepared separately from that intended for other purposes, a comparatively small amount of extra care would diminish enormously the initial bacterial contamination of the raw product. Under present conditions the submucous coat of the intestine, originally sterile, becomes excessively infected in the slaughter-house, the infection being intensified by subsequent soaking in alkaline watery solutions.

The technique of testing the sterility of catgut is then discussed, and the writer insists that when the gut has been treated with antiseptic the action of that antiseptic must be annulled before the bacteriological test is made, as otherwise its inhibiting action may give deceptive results. 'Sterile' catgut washed in water to remove the fluid in which it has been stored, will frequently fail to grow anything on culture. But if the antiseptic incorporated in the catgut be removed before the culture is made, organisms will be grown from many samples sold as 'sterile'. It is by this technical step that Professor Bulloch has been able to prove so many samples to be infected, and though nobody would question the validity of his argument as regards the bacteriological experiment, the relative importance of this factor in regard to catgut buried in the human body may be doubted. That the author is alive to this aspect of the problem is shown by the only flight of fancy which he allows to creep into the scientific inquiry. While pondering over the thought that if catgut usually contained pathogenic bacteria it would have been discarded years ago, he admits that " a ligature charged with a chemical disinfectant has been held to be protected against infection during its career of activity "; and " it might indeed be argued that a small number of bacteria in catgut might have some definite antigenic effect and promote some slight reaction which was not necessarily detrimental ".

The organism most commonly found in catgut is *B. mesentericus ruber*, which is extremely resistant to chemicals and heat, but is apparently non-pathogenic. Those who are responsible for the well-being of patients will not readily be comforted by the assurance that the organisms are not virulent. It has frequently been observed that even the finest catgut sutures if placed close beneath a skin incision give rise to a reaction which appears about a week after the operation, accompanied by an exudation of serum which, though not infected with pyogenic organisms, interferes with healing, and may be attributable to so-called 'non-pathogenic' bacteria. Also it is not unreasonable to assume that where non-pathogenic organisms occur the probability of the appearance of pathogenic bacteria is greatly increased; and it has been shown that a mixture of two strains of organisms, individually harmless, may produce generalized sepsis in animals. The presence of non-pathogenic bacteria is not, therefore, to be regarded as unimportant. On the other hand, Professor Bulloch, when reviewing the literature of catgut infections in man, comes to the conclusion that little of it will bear scrutiny, and that 'catgut infections' usually rest on clinical conjecture.

Even in the extremely interesting and critical survey of the literature on post-operative tetanus, he states that " although there may be a suspicion against catgut it remains for the most part only a suspicion. In almost all the cases of 'catgut' tetanus there have been other sources of infection which have either been left unconsidered or have not been adequately differentiated before the diagnosis of 'catgut' tetanus was made ". One point which may be of much importance in regard to tetanus is that it has been confined almost entirely to abdominal operations.

The bulk of the original experimental work recorded consists of a large number of tests for sterility of samples of catgut treated with various disinfectants. So many variable factors had to be considered that the undertaking has assumed gigantic proportions; and the results of the investigation are certain to modify many of the reader's previous impressions with regard to the efficacy of certain bodies as disinfectants. Starting with carbolic acid and the mercurial compounds, he examines chromic acid, the silver compounds, several oils, formalin, and picric acid in turn. It is not till he comes to hydrogen peroxide, and especially to aqueous solutions of iodine, that he obtains chemical sterilization which could be adapted to the

preparation of catgut on a big scale. As a result of many hundreds of experiments he is able to confirm the claims of Claudius that 1 per cent aqueous solution of iodine and potassium iodide applied for eight days will sterilize the most contaminated catgut. That the solution must be aqueous and not alcoholic is shown by the fact that 1 per cent iodine in absolute alcohol will not sterilize ligatures in forty days. The watery solution apparently enables iodine to penetrate catgut and even the spores of bacteria, the only disadvantage of the method being the deterioration which takes place in the tensile strength when ligatures are kept in iodine for a prolonged period.

Apart from the chemical methods, catgut may be sterilized by heat. Provided the material is absolutely dry it can be sterilized by hot air, but there is still a risk of its deteriorating as a result of the treatment. Heating in alcohol is efficient only in the presence of water, and this method cannot be followed since the combination of water and heat ruins the catgut as a ligature.

Sterility is not the only requirement, and in the second part of the Report Dr. Lampitt and Mr. Bushill describe their studies of the effect of disinfection upon the tensile strength of ligatures. They draw attention to the importance of the reaction of the liquids in which catgut is washed, acid preventing degradation but reducing tensile strength, whereas an alkaline wash increases it. They show that iodine treatment tends to make a ligature more brittle, and that the presence of an acid (presumably hydriodic acid) is responsible for the reduction in tensile strength. This change may be reduced or eliminated by the addition of potassium iodate.

They also refer to the disadvantages of prolonged treatment with iodine, and recommend that the excess of iodine be removed and the ligatures stored in 70 per cent alcohol, to which glycerol may be added to maintain the flexibility of the ligature.

Their contribution includes observations with regard to the method of spinning the ribbons in order to obtain optimum strength ; and they were also able to prove that ligatures wound on glass tubes and immersed in iodine—thus being under tension during treatment—were distinctly stronger than those which were merely looped before being placed in the solution.

It is felt that this Report contains all the information about surgical catgut that is required to guide those who will be called upon to control its preparation in future. And it is to be hoped that as a result of the labours of Professor Bulloch and his collaborators the ideal ligature—sterile, strong, supple, and absorbable—may take the place of the article which at present, even when coming from the most reputable sources, is not above suspicion.

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**La Pratique chirurgicale illustrée.** By VICTOR PAUCHET. Fasc. XIV. Royal 8vo. Pp. 239, with 178 illustrations by S. Dupret. 1929. Paris: Gaston Doin et Cie. Fr. 65.

IN this volume Victor Pauchet is assisted by Leon Monier, who contributes an article on dental surgery, and by M. P. Mornard, who writes on myeloma of the mandible, plastic elevation of the mammary glands, and on face-lifting. No doubt there is a demand for procedures which remove wrinkles, but the operation is not without risk. We have seen an operation of this nature followed by partial facial paralysis. A face robbed of its expression seems a poor substitute for wrinkles.

L. Bérard contribute a two-page article on Albee's operation, with twenty-four illustrations. P. Petit-Dutailles describes an elaborate procedure for uterine prolapse which combines amputation of the cervix, vulvovaginal perineorrhaphy, suture of the levatores ani in front of the rectum and beneath the bladder, and shortening of the round ligaments. The method is extremely well illustrated. Victor Pauchet writes on exophthalmic goitre, cirrhosis of the liver simulating cancer of the stomach, gastrectomy for high gastric ulcer, trans-meso-colic posterior gastrojejunostomy, hemicolectomy for intussusception secondary to carcinoma at the ileocæcal valve, chronic inflammation of the great omentum, nephrectomy for hydronephrosis, and chronic suppuration of inguinal glands. All these articles are up to the usual high standard of his work. They represent for the most part standard surgery.

As in former volumes, the illustrations by S. Dupret are the great attraction, and they speak for the text.

**Principles and Practice of Minor Surgery. A Text-book for Students and Practitioners.** By EDWARD MILTON FOOTE, A.M., M.D., Visiting Surgeon, St. Joseph's Hospital, etc.; and EDWARD MEAKIN LIVINGSTONE, B.Sc., M.D., Assistant Visiting Surgeon, Bellevue Hospital, etc. Sixth edition. Pp. 787 + xl, with 420 illustrations. 1929. London and New York: D. Appleton & Co. 35s. net.

No book on minor surgery which we have read so completely fills its self-appointed rôle as does this volume. In this, the sixth edition of the work, Dr. Foote has had Dr. Livingstone as collaborator and part author. Their aim has been to cover the whole ground of minor surgery both in general surgery and in the specialties.

The book is divided into three parts. Part I deals with Minor Surgical Technique, and gives a lucid account of the principles and practice of asepsis, bandaging, surgical apparatus, anæsthesia, and minor operations. There is also a particularly valuable chapter, entitled, "The Manœuvres of Minor Surgery", which deals with sutures and the tying of knots. It is a chapter such as the young surgeon frequently looks for in text-books, but rarely finds. The sections are very well illustrated with easily understandable photographs.

Part II deals with the Principles of Diagnosis and Treatment, and gives broad clinical studies of groups of diseases—inflammations, wounds, specific infections, including tubercle and syphilis, and congenital defects.

Part III is written regionally and deals with the Practice of Minor Surgery, and occupies two-thirds of the book. It gives concise accounts of minor affections of the head, neck, trunk, genito-urinary organs, rectum, arm and hand, leg and foot; and each section is subdivided into injuries, inflammations, tumours, and deformities. While some of the sections on diagnosis are somewhat sketchily done—as in the description of some of the fractures—the sections on treatment are written with great care, the authors' personal views being clearly stated, but due prominence being given to all modern methods which are effective. There are a few omissions, but in general they are not serious ones—for instance, in the section on boils (p. 373) treatment by cupping is omitted.

The chief criticism we would offer is that at times the authors make excursions into regions which we would describe as major surgery. But, after all, the dividing line is a broad one, and, taking the book as a whole, the division between minor and major is very well kept. The work is an established favourite, and we have no hesitation in saying that it will prove of great use to new generations of senior students and young surgeons dealing with casualty and out-patient cases. It would be invaluable on the shelves of a general practitioner. The book is very well produced, the photographs are carefully chosen, and there is a comprehensive index.

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**Orthopædic Surgery.** By Sir ROBERT JONES, Bart., K.B.E., C.B., Ch.M. (Liverpool), F.R.C.S. (England, Ireland, and Edinburgh), F.A.C.S., Emeritus President, British Orthopædic Association, etc.; and ROBERT W. LOVETT, M.D., F.A.C.S., late John B. and Buckmaster Brown Professor of Orthopedic Surgery in Harvard University. Second edition, revised. Crown 4to. Pp. 807 + xvi, with 792 illustrations. 1929. London: Humphrey Milford. £2 12s. 6d. net.

EXTENSIVE alterations have been made in the second edition of this book, and three new collaborators, Dr. Allison and Dr. Ober from America, and Mr. Harry Platt from England, now assist Sir Robert Jones. The alterations take the form of omissions as well as additions. It is, perhaps, a good point that some of the more special operations, such as those for reconstructing the external lateral ligament and crucial ligaments of the knee, have been left out. These operations are not very often required, and can quite well be looked up in their original descriptions. It might be possible to suggest further omissions of the same character. The additions to the book all improve its value. The short account of osteomyelitis, in which Mr. Platt's hand can be recognized, gives one of the best descriptions of this important condition to be found anywhere in literature. Instead of dealing only with mal-union of fractures, a chapter has now been introduced which includes a brief general account of fracture treatment. In view of the fact that the orthopædic

specialist has been called upon more and more to treat recent fractures, it may be expected that inclusion of this subject will be essential in orthopædic text-books in the future. There are many other additions of value; but the last new chapter, that on amputations and artificial stumps, has been kept so brief that it can scarcely be considered to serve its purpose.

In a work of such size and elaboration there is naturally much to criticize, and perhaps the most obvious point is that the multiplicity of authorship sometimes prevents a clear and dogmatic statement of opinion, so that although the experienced orthopædic surgeon may be able to get valuable statements of varying ideas and methods, the less experienced student may find it difficult to get a perfectly clear view of some of the subjects. Treatment of tuberculosis of the hip is a case in point; the treatment of the Boston School and of the Liverpool School is described. The single Thomas's hip splint, which in most clinics is looked upon as obsolete, still remains, and under the account of traction a discussion of opinions is given which really leaves the reader undecided as to the exact place and value of the method. The illustrations are increased in number by nearly a hundred. Actually the new illustrations are more than this, because many old ones have been omitted. There are, however, still illustrations which might be left out or replaced with benefit. A few of the radiographs are far from clear, and several have been wrongly inserted.

These points of criticism are, however, minor matters, and only point to the fact that, however excellent a book may be, it is generally susceptible of improvement. The work remains one of the best orthopædic text-books available, suitable both for students and for orthopædic specialists. There is very little in orthopædic surgery that is not adequately included.

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**Introduction to Anatomy.** By N. S. SAHASRABUDHE, M.S., Lecturer in Anatomy, R.M. School, Nagpur; Prince of Wales Fellow and Medallist, Bombay University (1926–7), etc. With Foreword by Dr. Y. G. NADGIR, M.S., F.C.P.S., Professor of Anatomy and Embryology, Grant Medical College, Bombay. Crown 8vo. Pp. 229 + vii. Illustrated. 1929. Nagpur: R. T. Deshmukh.

THE author states that it has been his endeavour to help students when beginning the study of human anatomy. He has certainly fulfilled his object, even "though parts of the book may be regarded as too elementary to justify their inclusion." He shows how knowledge of the medical curriculum may be applied to the elucidation of others, as when he demands of the student that he shall make use of his knowledge of physics in his study of the structure of the human body, in the comparison of the architecture of the human skeleton to the formation of an arch. Throughout the small volume the student of anatomy is constantly urged to ask himself the questions 'how and why?' This is surely anatomy taught from the right angle. We can only regret that the author has been so modest in his aims, as a volume of advanced anatomy written on the same lines would have a definite surgical value.

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**Surgical Pathology.** By CECIL P. G. WAKELEY, F.R.C.S., F.R.S.E., Hunterian Professor, R.C.S. England; Junior Surgeon, King's College Hospital; and ST. J. D. BUXTON, M.B., B.S. (Lond.), F.R.C.S., Junior Surgeon and Junior Orthopædic Surgeon, King's College Hospital. Medium 8vo. Pp. 904 + xvi, with 392 illustrations, many of which are fully coloured. 1929. Bristol: John Wright & Sons. 45s. net.

THIS is a big book, measuring 9½ in. by 6½ in. There is a full table of contents, a list of illustrations, and an index occupying 39 pages. The work is intended to cover the whole field of surgical pathology, as one would expect from its size. The arrangement is like that found in several of the well-known text-books on surgery, and it suggests that the clinical matter from such a work has been deleted and the pathological sections somewhat elaborated. The first nineteen chapters are devoted to a general consideration of pathological processes and some specific conditions, and the remainder of the book—extending to fifty-six chapters—is arranged on a regional

basis. The illustrations are copious and, in most cases, very good indeed. Some of the coloured pictures—such as *Fig.* 7, an illustration of moist gangrene of the foot—are really beautiful. Other of the illustrations are not so good, and several are ill-chosen. *Fig.* 22 showing a penile chancre is quite an interesting example of such a lesion, but it is not the characteristic situation for a chancre on the penis. The illustration of a gummatous testicle (*Fig.* 372) is poor, and surely a better example not would have been very easily obtained. *Fig.* 389, representing a hydrosalpinx, is distinctive and ill compares with the very good picture of tubal mole on a near-by page. *Fig.* 232, called ' Pott's puffy tumour ', is so obviously misnamed that it makes one look for the table of Errata which, by-the-by, does not exist. It is clearly an example of ' Cock's peculiar tumour ', and bears no resemblance to the condition associated with the name of Percivall Pott, which, after all, is a condition only subject to diagrammatic representation.

In the section devoted to syphilis the condition of epiphysitis is merely mentioned under the head of congenital syphilis, and though it is briefly dealt with in the section devoted to diseases affecting the skeleton, there is no cross-reference to guide the reader. This want of cross-references is constantly felt by the reader, and their absence undoubtedly does the book some injustice.

It is scarcely enough to say of malignant tumours that " They are irregular and have no capsule. They invade the surrounding tissues. They form secondary growths (metastases) in other parts, and tend to recur if removed. . . ." Surely the fact that if unrestrained they ultimately destroy life is the criterion of their true nature. Chordoma, we are informed, " occurs in the region of the notochord, more commonly the anterior end, at the base of the skull ". Surely a little more precise information is necessary, and it would have been well to refer to those very carefully recorded cases where this interesting tumour occurred at the caudal end of the body. It is surprising to read that " a true lipoma probably arises in the dura of the skull, and may cause cerebral compression ; or if present in the spinal canal, it may cause signs of compression paraplegia ". Such a statement would have been more useful if it had been authenticated by a reference, but these appear to have been purposely and rigidly excluded throughout the work.

The book contains some loose statements and contradictions. For instance, in the section on myeloma, it is stated that in the lower limb the sites of election are " the upper end of the tibia, the lower end of the femur, and perhaps the upper end of the fibula or patella ". But in dealing further on with tumours of bones, under the same heading, the reader is informed that the patella is among the rare sites to be distinguished from the places of election.

In talking of bone cysts, we read that " multiple hydatid cysts may occur in bones, a conglomeration of daughter cysts with no mother cysts is found ". This is true enough, but is a statement which must leave the uninitiated in some considerable doubt as to the features of hydatid disease in bone. It is true that there is a poor illustration of hydatid affection of the femur and tibia on a distant page, but this is not referred to in the text nor in the index under hydatid cysts. There are only six words of description, and there is no mention of pathological fracture. This subject of hydatid disease illustrates the labour of using the book largely due to the omission of cross-references either in the text or in the index.

The important subject of cardiospasm is only allotted six lines and, as may well be judged, there is no real account of the condition, nor any discussion as to its possible causation. Similarly, the section on duodenal ulcer is very poor and occupies only one page, while gastrojejunal ulcer, with all its multitudinous possibilities, fares no better than cardiospasm, with only six lines. Pylephlebitis receives similar scant attention. The section on the pancreas is also disappointing. One looked for a reasonable account of inflammatory effusions into the lesser sac, but that interesting condition is merely dealt with in a few lines, and without any reference to the name of Jordan Lloyd. Under the heading of cysts affecting the pancreas there is no mention whatever of this condition.

In a book of this size one would naturally expect to find most of the available knowledge with regard to surgical pathology, and if that had been provided the authors might be excused for many of the omissions on debatable points. Of all the

sections in the book that on the ear, nose, and throat is certainly the best, and it is a relief to turn to its well arranged pages and succinct descriptions.

Nevertheless, in spite of all that has been said, let us hope that the authors will not be entirely discouraged, for there is still a demand for a really good work dealing with surgical pathology in the English language, and their book certainly provides a framework. It is because we realize that this framework is essentially good, and that the number of illustrations with the accuracy and beauty of their reproduction is so notable, that we feel it necessary to be critical about errors and omissions, which, after all, are matters of detail easily susceptible of amendment.

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**Hydatid Disease : its Pathology, Diagnosis, and Treatment.** By HAROLD R. DEW, M.B., B.S., F.R.C.S., F.A.C.S., Hon. Surgeon to Out-patients, Melbourne Hospital, etc. Royal 8vo. Pp. 429, with 87 illustrations. 1928. Sydney : The Australian Medical Publishing Co. Ltd.

"THIS book marks the culminating point in a series of researches on the biology, pathology, and diagnosis of hydatid disease which, initiated by Dr. N. H. Fairley, have been carried on at the Hall Institute during the past five years." "The greater part of the researches embodied in the book have been carried out at the Walter and Eliza Hall Institute of Research in Pathology and Medicine, Melbourne." These words from the preface sufficiently show the origin of the book. The first seven chapters treat of the history, etiology, and prophylaxis, the geographical distribution, development, and general pathology of hydatid disease, with special reference to Australian conditions. Then follow chapters on special diagnostic methods and hydatid anaphylaxis. The last eighteen chapters describe the disease as it occurs in the liver and other parts of the body. Full regard is given throughout the book to the wonderful work of Dévé, of Rouen, to whom more than to any other individual the elucidation of the exact development of the cyst in man is due.

To those of us who see so little of the disease in this country the description of hydatids in Melbourne is a revelation. The presence of the disease wherever sheep-rearing is practised on a big scale is shown to be due to the careless manner in which fresh offal from slaughtered animals is left for dogs to consume. As sheep-rearing has spread to other countries than Australia—South America, for example—so hydatid disease has become frequent in man. The old theory that watercress is the causative factor is shattered by proof that ova are almost invariably spread to man through actual contact with dogs. The possibility of ova living over long periods of intense cold and great heat in wet or dry surroundings and of being air-borne into water-supplies is carefully considered.

The development of the cyst is minutely described with admirable illustrations, and an attempt is made to show how daughter cysts come to be developed. The chapters on treatment are well done. The preliminary injection of formaldehyde before emptying a cyst is still the favourite preventive of local infection ; the introduction of black cloths to pack off the area enables the operator to recognize escaped brood capsules more easily and remove them. That vexed question of how to deal with the cavity left in the liver after removal of the cyst is fully dealt with, though in this, as in other details of treatment, there is nothing new.

The book is well written and beautifully illustrated. It is easily the best work on hydatids in our language.

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**The Treatment of Fractures.** By LORENZ BÖHLER, M.D., Chief Surgeon and Director of the Vienna Accident Hospital. Authorized English translation by M. E. STEINBERG, M.S., M.D., of Portland, Oregon. Pp. 185 + x, with 234 illustrations. 1929. Vienna : Wilhelm Maudrich. 21s. net ; $5 ; R.M. 21.

FOUR years ago a special hospital was established in Vienna that was devoted exclusively to the treatment of injuries. This hospital, which now contains one hundred beds, forms part of the organization of the Vienna Insurance Company, and is

responsible for the treatment of accidents in a considerable population of workers in Vienna and lower Austria.

Dr. Lorenz Böhler, the Surgeon-in-chief to the hospital, has already gained a world-wide reputation both as an exponent of the art of fracture treatment and as a surgical teacher. The methods he has used with great success are now fully described in a volume of less than two hundred pages adequately translated into English by Dr. M. E. Steinberg, of Portland, Oregon. In his preface Dr. Böhler states that success in treatment depends not only on the surgeon's skill but also on organization. The truth of this observation is obvious to all who have witnessed the team work of the Vienna Insurance Hospital.

Böhler is an apostle of the doctrine of rest, and his teaching is strongly tinged with the principles which in this country we associate with the names of Hilton and Hugh Owen Thomas. Local anæsthesia is used for the reduction of the majority of fractures, the hæmatoma and tissues around the bone-ends being infiltrated with 2 per cent novocain. Skeletal traction by Steinmann nails or ice-tong calipers is employed in the lower limb not only for compound injuries but also for many of the simple fractures. Early walking in a plaster-of-Paris cast applied without any skin covering is practised, and on removal of the cast a zinc, gelatin, and gauze dressing is applied from the toes to below the knee, which effectively prevents œdema. In compound fractures, after débridement of the wound, the skin only is sutured and all wounds are exposed to the air. Upper limb fractures even when involving the hand are treated with the limb elevated. Active movements are encouraged early, but passive movements are condemned. Massage and electrical stimulation of muscles play no part in the armamentarium of Böhler's clinic.

Perhaps the most striking section of this book is the one dealing with fractures of the os calcis, a subject to which the author has made a most original contribution. A method is described in which the displacement is corrected and the broken bone remoulded accurately. Strong traction is first applied to the posterior end by means of an ice-tong caliper, counter traction being maintained by a caliper gripping the shaft of the tibia. After the length of the bone is restored, the lateral expansion is corrected by powerful compression below the malleoli exerted by a special 'redresseur'.

No surgeon who is treating fractures seriously can afford to overlook Böhler's monograph.

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**Museum, Royal College of Surgeons of England. Guide to the Surgical Instruments and Objects in the Historical Series with their History and Development.** By C. J. S. Thompson, M.B.E., Hon. Curator of the Historical Section of the Museum. With a Foreword by the Conservator, Sir Arthur Keith, M.D., F.R.C.S., F.R.S. Issued by order of the Council. Demy 8vo. Pp. 92 + iv. Illustrated. 1929. London: Printed for the College and sold by Taylor and Francis, Red Lion Court, Fleet Street. 2s. 6d. net.

"Three removes are as bad as a fire", says the collector of unconsidered trifles. "By no means," replies his wife, "three removes are as good as a fire", for in this manner she gets her cupboards cleared out and the miscellaneous collection of years, spoken of by her in modern phraseology as 'junk', makes way for a fresh collection. The Royal College of Surgeons of England has never moved in the 130 years of its corporate existence, nor has it been subjected to the ordeal of fire. Its cupboards, therefore, are stuffed full of presents given by its numerous friends. It has recently obtained the services of Mr. C. J. S. Thompson, M.B.E., who did much to build up the wonderful Wellcome Historical Medical Museum, and whose name is well known as the writer of a series of books on Alchemy, Magic, and the Art of the Apothecary. Mr. Thompson has a perfect genius for unearthing objects of medical interest and for describing them in such a manner as to be interesting alike to the doctor and to those who have no medical knowledge. A few years ago the late Mr. Alban Doran described in detail the various instruments preserved in the College Collection, and his valuable typewritten catalogue is preserved in the Library. Mr. Thompson has now produced a guide to the same collection based on general lines and in a

cheap and handy form. It contains all that is required except by students who are engaged in tracing such parts of the development of the mechanical side of surgery as can be shown by the evolution of the instruments employed. Students so working must of necessity use Mr. Doran's catalogue and visit the cases in which the instruments are kept. Sir Arthur Keith, Conservator of the Royal College of Surgeons Museum, says in his Foreword: "It serves not only as a guide to the more important exhibits but also as an introduction to the very interesting principles which underlie surgical inventions. Indeed the book is more than a Guide; it is an important contribution to the history of Surgery."

The first section deals with surgical instruments, in which the museum is extraordinarily rich. There is a remarkable plate showing the evolution of the scalpel, an instrument which seems to have passed down the ages with very little change. It has always been forged in a single piece of copper, bronze, iron, or steel, according to the metal in use at the time of its manufacture, but the blade has always retained the shape of the curved flint chip used by palæolithic man. A sharper and better edge could undoubtedly have been obtained on a metal instrument, but for ritual purposes the flint knife still holds its own in many circles. It was not until the first quarter of the present century that American ingenuity devised a scalpel with interchangeable blades which could be fitted to a separate handle, but even these blades retain the bow-shaped outline of the original flint flake. To complete the series one of these scalpels should be included in the collection.

The origin and development of the trephine is also amply illustrated. For some unknown reason, or perhaps for many different reasons, the removal of portions of the skull bones has always presented a peculiar fascination for races widely separated ethnologically, and it is still practised by tribes so near Europe as the Berber Arabs. In prehistoric times a scraper of shell, flint, or obsidian was used to remove a circumscribed piece of bone from the dead or the living. Holes were drilled at a later period with an auger or Archimedian drill, the holes being afterwards connected until a crown of bone could be removed. The trephine as it is now known does not seem to have come into use until late in the sixteenth century, its invention being attributed to Fabricius of Aquapendente (1537–1619), whose lectures were attended by Dr. William Harvey. The instrument underwent many slight modifications at the hands of surgeons in all countries until it became standardized in its present form, and, having become so standardized, surgeons returned to the older method recommended by Lanfranc, who died in 1315, when they wished to turn down a flap of bone, and have thus gone back from trephining to trepanning.

The College Museum is rich, too, in bougies and catheters, in lithotomy forceps, gorgets, and lithotrites, as well as in obstetrical and gynæcological instruments. When vesical calculus was common every surgeon in large practice devised some special instrument for its removal. The Museum contains more than fifty of these inventions—some safe and useful, others which must have been dangerous even in the hands of their authors. The development of midwifery forceps can also be followed out very completely from the Chamberlen forceps of 1600 to the axis-traction forceps of 1883. In like manner the evolution of the stethoscope and of the clinical thermometer can be traced step by step, and it can be seen that, although in their inception they were of foreign origin, in their present form they are essentially English.

The fame of Lister as a scientific surgeon has done much to eclipse the reputation which he would have otherwise attained as a skilful inventor. Mr. Thompson has done well, therefore, to give a detailed account of the Lister Collection gathered together and sumptuously housed by the pious efforts of his nephew, the late Sir Rickman J. Godlee. The collection consists of three groups. The first, instruments devised, modified, or freely used by Lister, examples being: an abdominal tourniquet, a sinus forceps, a urethral forceps, a lithotrite, and a bistoury. The second group are instruments used by his father-in-law, James Syme; whilst the third group is a collection of over forty instruments many of which had already become obsolete when he had them, so that their value is wholly sentimental.

The Historical Room contains a variety of objects of varying interest. There

are chastity belts, and an electrical machine used in the daily practice of John Birch, surgeon to the second troop of Horse Grenadier Guards, as early as 1788; whilst on the morbid anatomy side are portions of the intestine believed to have been removed from the body of Napoleon Bonaparte; a rib of King Robert the Bruce which was fractured in a joust; the thymus gland of Princess Louise, who died in 1832; the root of the aorta of King William IV showing calcification of the valves; and the hands of Thomas Beaufort, third son of John of Gaunt, who died in 1427. Here, too, may be seen the embalmed body of the young woman from whom John Sheldon, the best anatomist and embalmer of the Hunterian School, contracted syphilis, and the first wife of Martin van Butchell, dentist and friend of John Hunter. She was embalmed by William Hunter and Mr. Cruickshank in 1775. Lastly there are shrunken heads from Ecuador and pieces of skin from Danes flayed for pillaging English churches.

It will thus be seen that Mr. Thomson has described a collection to suit all tastes. His descriptions are so clear that the guide will be useful even to those who are unable to visit the collection itself. The frontispiece is a representation of "An Apothecary's Signboard" in the possession of the College. It is dated 1623 and represents the sturdy owner engaged in his various avocations. More properly it should be labelled "The Signboard of a Barber-surgeon" of the period. Finally, there is an excellent index.

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## *BOOK NOTICES.*

*[The Editorial Committee acknowledge with thanks the receipt of the following volumes. A selection will be made from these for review, precedence being given to new books and to those having the greatest interest for our readers.]*

**St. Bartholomew's Hospital Reports.** Edited by Sir Thomas Horder, Bart., K.C.V.O., Ronald G. Canti, Wilfred Shaw, W. Langdon Brown, W. Girling Ball, and Geoffrey Evans. Vol. LXII. Demy 8vo. Pp. 262 + xxv, illustrated. 1929. London: John Murray. 21s. net.

**Radium Practice, 1929.** Edited by Rock Carling and the *Westminster Hospital Reports* (Vol. XXI) Editors, Stanford Cade and Donald Paterson. Demy 8vo. Pp. 258 + viii, with 12 illustrations. 1929. London: H. K. Lewis & Co. Ltd. 7s. 6d. net.

**Gastric and Duodenal Ulcer.** By Arthur F. Hurst, M.A., M.D. (Oxon.), F.R.C.P., Senior Physician to Guy's Hospital; and Matthew J. Stewart, M.B. (Glasgow), F.R.C.P., Professor of Pathology, University of Leeds. With the co-operation in the Radiological Section of P. J. Briggs, M.A. (Cantab.), M.R.C.S., L.R.C.P., Radiologist to New Lodge Clinic and the Medico-Neurological Clinic, Guy's Hospital. Crown 4to. Pp. 544 + xvii, with 159 illustrations and 10 coloured plates. 1929. London: Humphrey Milford. 63s. net.

**Die Chirurgie. A System of Surgery.** Edited by Professors M. Kirschner (Tübingen) and O. Nordmann (Berlin). Fasc. 25 (Vol. III). Royal 8vo. Pp. 387–608, with 105 illustrations in the text and 8 coloured plates. 1929. Berlin and Vienna: Urban & Schwarzenberg. RM. 15.

**The Treatment of Varicose Veins of the Lower Extremities by Injections.** By T. Henry Treves-Barber, M.D., B.Sc. Crown 8vo. Pp. 120, illustrated. 1929. Bristol: John Wright & Sons Ltd. 6s. net.

**Westminster Hospital Reports.** Edited by Stanford Cade and Donald Paterson. Vol. XX, 1924–1928. Demy 8vo. Pp. 343 + viii, illustrated. 1929. (Published October.) London: H. K. Lewis & Co. Ltd. 7s. 6d. net.

**The Injection Treatment of Varicose Veins.** By A. H. Douthwaite, M.D., F.R.C.P. (Lond.), Assistant Physician to Guy's Hospital. Fifth edition. Crown 8vo. Pp. 58 + x. 1929. London: H. K. Lewis & Co. Ltd. 4s. net.

**Hæmodynamics. The Mechanism of Venous Capillary and Lymphatic Flow; Œdema; and Injection Treatment of Varicose Veins.** By P. B. Kittel, F.R.C.S., Assistant Surgical Officer at the Royal Northern Hospital, London. Crown 8vo. Pp. 196 + xi, with 3 plates and other illustrations. 1929. London: H. K. Lewis & Co. Ltd. 10s. net.

**The Mobilization of Ankylosed Joints by Arthroplasty.** By W. RUSSELL MACAUSLAND, M.D., Surgeon in Chief, Orthopedic Department, Carney Hospital; and ANDREW R. MACAUSLAND, M.D., Orthopædic Surgeon, Carney Hospital, Boston, Mass. Medium 8vo. Pp. 252 + vii, with 154 engravings. 1929. Philadelphia: Lea & Febiger. $4.00 net.

**Practical Local Anæsthesia and its Surgical Technique.** By ROBERT EMMETT FARR, M.D., F.A.C.S. Minneapolis. Second edition, thoroughly revised. Royal 8vo. Pp. 611 + xxiii, with 268 engravings and 16 plates. 1929. London: Henry Kimpton. 42s. net.

**Testicular Grafting from Ape to Man.** By SERGE VORONOFF, Director of the Laboratory of Experimental Surgery of the Collège de France, etc.; and GEORGE ALEXANDRESCU, Formerly Assistant at the Institut d'Histologie, Staff Hospital Physician, Bucharest, Roumania. Translated by THEODORE C. MERRILL, M.D. 8vo. Pp. 125 + viii, with 39 illustrations. 1929. London: Brentano's Ltd.

**Minor Surgery.** By FREDERICK CHRISTOPHER, M.D., F.A.C.S., Associate in Surgery at Northwestern University Medical School. With a Foreword by ALLEN B. KANAVEL, M.D., F.A.C.S., Professor of Surgery, Northwestern University Medical School. Medium 8vo. Pp. 694, illustrated. 1929. Philadelphia and London: W. B. Saunders, Co. 36s. net.

**Nouveau Traité de Médecine: Le Cancer.** Fasc. V (Vol. II). By GUSTAVE ROUSSY, with the collaboration of ROGER LEROUX and MAURICE WOLF. Second edition, entirely reset. Royal 8vo. Pp. 846, with 284 illustrations and 19 plates of four colours. 1929. Paris: Masson et Cie. Fr. 100.

**La Pratique du Pneumothorax thérapeutique et de la Collapsothérapie.** By F. DUMANEST and P. BRETTE. Third edition of *La Pratique du Pneumothorax thérapeutique* by F. DUMAREST and Ch. MURARD. With the collaboration of F. GUILLOT, P. GARCIN, Assistants; J. ANGIRANY, Radiographer at the Sanatorium Felix Mangini, à Hauteville. Preface by Dr. F. BEZANCON. Medium 8vo. Pp. 409 + xiii, illustrated. 1929. Paris: Masson et Cie. Fr. 50.

**Chirurgie des Os et des Articulations des Membres.** By P. LECÈNE, Professeur à la Faculté de Médecine de Paris; Chirurgien de l'Hôpital Saint Louis. With the collaboration of P. HUET, Chirurgien des Hôpitaux de Paris. Pp. 591, illustrated. 1929. Paris: Masson et Cie. Paper covers, Fr. 125; bound, Fr. 140.

**Die Wiederbelebung: Eine zusammen-fassende Darstellung ihrer Theorie und Praxis.** By Professor Dr. OSKAR BURNS and Dr. KARL THIEL, der Medizinischen Universitäts-Poliklinik, Königsberg. Super Royal 8vo. Pp. 109, with 26 illustrations. 1930. Berlin and Vienna: Urban & Schwarzenberg. RM. 9.

**Applied Anatomy. The Construction of the Human Body considered in Relation to its Functions, Diseases and Injuries.** By GWILYM G. DAVIS, M.D., Late Professor of Orthopedic Surgery and Associate Professor of Applied Anatomy in the University of Pennsylvania. Revised by GEORGE P. MULLER, M.D., Professor of Clinical Surgery in the University of Pennsylvania. Eighth edition revised. Super Royal 8vo. Pp. 638 + xii, with 656 illustrations mostly from original dissections and many in colour by Edwin F. Faber. 1929. London: J. B. Lippincott Co. 42s. net.

**Chirurgie. Teil I: Allgemeine Chirurgie.** Revised by Prof. Dr. D. KULENKAMPFF, Zwickau. Sechste mit der fünften übereinstimmende Auflage. (Breitenstein's Rep. Nr. 13a.) Crown 8vo. Pp. 187, illustrated. 1929. Leipzig: Johann Ambrosius Barth. Paper covers, RM. 4.80; bound, RM. 5.60.

**Guy's Hospital Reports.** Edited by ARTHUR F. HURST, M.D. October, 1929. Vol. LXXIX (Vol. IX Fourth Series). No. 4. Medium 8vo. Pp. 379–500, illustrated. 1929. London: Lancet Ltd. Annual subscription, £2 2s. net, or 12s. 6d. net per issue.

**Die diätetische Vor- und Nachkur bei der operativen Behandlung der Lungentuberkulose.** By ADOLF HERMANNSDORFER. Crown 4to. Pp. 18, with 21 plates. 1929. Leipzig: Johann Ambrosius Barth. Paper covers, RM. 2.50.

**Anæsthesia and Anæsthetics.** By F. S. ROOD, M.B., B.S. (Durham), Anæsthetist to University College Hospital; and H. N. WEBBER, M.A., B.Chir. Cantab., Anæsthetist to University College Hospital. Demy 8vo. Pp. 292 + xi, illustrated. 1930. London: Cassell & Co. Ltd. 14s. net.

**Devils, Drugs, and Doctors. The Story of the Science of Healing from Medicine-Man to Doctor.** By HOWARD W. HAGGARD, M.D., Associate Professor of Applied Physiology, Yale University. Medium 8vo. Pp. 405 + xxii, illustrated. 1929. London: William Heinemann (Medical Books) Ltd. 21s. net.